

OTITIS MEDIA

(MASTOID DISEASE)

CHARLES J. HEATH

BAILLIÈRE, TINDALL & COX

THIS BOOK
BELONGS TO
Col. C. Richardson White

Though many of my friends
are bad *Arithmeticians*, I find
some of them to be excellent
Book-keepers.—SCOTT.

If thou art borrowed by a friend,
Right welcome shall he be
To read, to study, not to lend—
But to return to me.

Not that imparted knowledge doth
Diminish learning's store;
But Books, I find, if often lent,
Return to me no more.

Read slowly—Pause frequently
— Think seriously — *Keep*
cleanly — and *Return duly*,
with the corners of the leaves
not turned down.

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DIAGNOSIS AND TREATMENT
IN CASES OF
OTITIS MEDIA
(MASTOID DISEASE)

BY

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*A Paper read before the Hunterian Society, London. Revised and
amplified by the addition of numerous notes and illustrations
explanatory of the indications for the performance of the
Author's conservative mastoid operation in order to save
the hearing of the discharging ear with per-
foration of the drum-head, whether caused
by inflammation (otitis media) or
by violence (shell-explosions)*

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8, HENRIETTA STREET, COVENT GARDEN

As the future is with the young it is to the young otologists that this pamphlet is dedicated, in the firm belief that within its pages they will find such guidance as will enable them to treat the discharging ear with confidence, precision and success. The preservation of the hearing of the community is "a national concern." At the last International Otological Congress during the discussion of my paper on "The prevention of the deafness and mortality which result from aural suppuration," a speaker asked me to give the indications for operation. In my reply I pointed out that this would be impossible in the few minutes at my disposal, as it would be necessary to enter into an extensive pathological dissertation; this and the indications for operation (in order to save the hearing) are to be found herein.

C. J. H.

LONDON.

January, 1919.

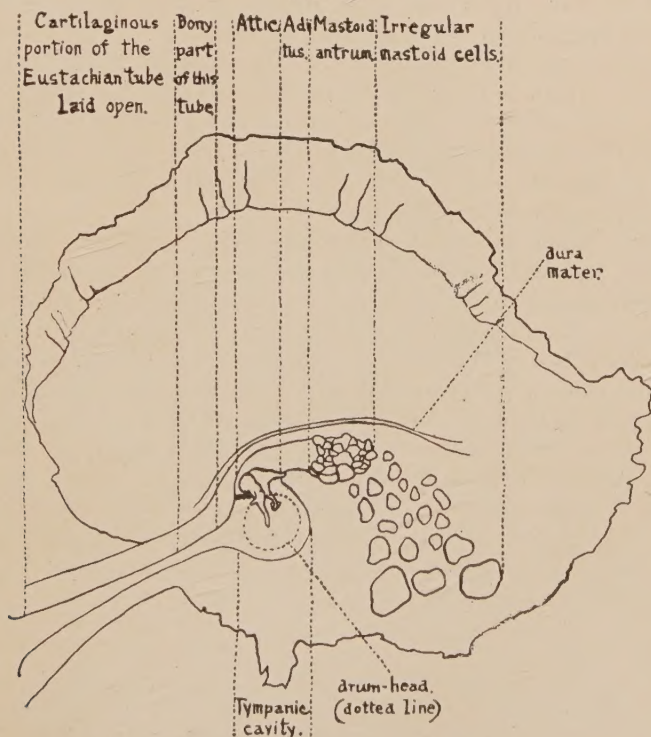
DIAGNOSIS AND TREATMENT

IN CASES OF

OTITIS MEDIA (Mastoid Disease).

IN consequence of the war suppurating ears are more prevalent than ever. A surgeon from the front told me that he examined 1,000 men on their first arrival in France, and found about 200 suffering from perforation of the drum-head and a chronic discharge from the

FIG. 1.



A diagram of the temporal bone, showing the size and situation of the middle-ear. It will be seen that the walls of the middle-ear channel are all smooth except in the mastoid antrum. Photographs of a bone, illustrating this important point, are given in Figs. 13 and 25. The smooth-walled parts of the middle-ear (the tympanum, attic and aditus) are lined with a much more vascular, defensive, and distensible mucous membrane than the rough-walled antrum.

ear. This shows that persistent aural suppuration (also known by the indefinite name otitis media, but really due, as I shall presently show, to disease of the bony walls or lining of the mastoid antrum, *i.e.*, mastoid disease) is one of the commonest of the ailments with which our Army is troubled. It consequently is, as Dr. Graham Brown has recently pointed out, "in reality a national concern" *—and a far larger number of aural surgeons are now needed than in time of peace; even then the supply was seriously inadequate.

To-night I propose to draw your attention only to the early stages† of the disease—the first few weeks—because this is the period during which we have the best chance of arresting the trouble and saving the hearing, and this, in the great majority of cases, we can do, with or without an operation, thereby saving also a number of lives which are sacrificed when, in deference to the "wait-and-see" teaching of the books, the suppuration is allowed to continue until dangerous symptoms arise. It is usual for otitis media which has been allowed to persist for three months to leave some deafness. This appears to be mainly due to inflammatory changes in the tympanic structures and to the deposit of new cells within them. These cells, from their inherent tendency to contract, are liable to impair the necessary mobility of the delicately balanced tympanic mechanism, and thus to render the patient deaf. Three months, therefore, is too long a period to postpone effective treatment if loss of hearing is to be prevented. Further, as four-fifths of those cases which recover spontaneously, without impairment of the hearing, do so within a month of the commencement of disease, a daily chart of the tympanic conditions, presently to be described, will soon afford evidence of the probability of this desirable result, or of the need of some more effective proceeding (the conservative mastoid operation) *in order to eradicate the disease in the mastoid antrum, the persistent discharge from which is the usual cause of tympanic damage and consequent deafness.*

* In a paper read at a meeting of the Queensland branch of the British Medical Association, June 17th, 1917, by Dr. Graham Brown, an aural surgeon on the staff of two of the Brisbane hospitals, and published in the *Medical Journal of Australia*, July 21st, 1917. Dr. Brown has served on the Western front, and has observed the prevalence of this disease in the Army.

† The prevailing lack of knowledge concerning the early stages of this disease, which results from the inadequate teaching of the books, is responsible, even in peace time, for the permanent loss of hearing in tens of thousands of people every year. Sir James Mackenzie has lately emphasised the importance of recognising and treating the beginnings of disease (*Edin. Med. Journal.*)

Such affections as measles, scarlet fever, diphtheria, influenza, sore throat, cold in the head, and occasionally naso-pharyngeal adenoids, as well as bathing and sitting in a draught, cause irritation, swelling and increased vascularity of the mucous membrane of the naso-pharynx and middle-ear, and of the Eustachian tube which establishes a communication between the two. This channel is always narrow (Fig. 2), yet its size varies in different individuals. A very small amount of inflamma-

FIG. 2.

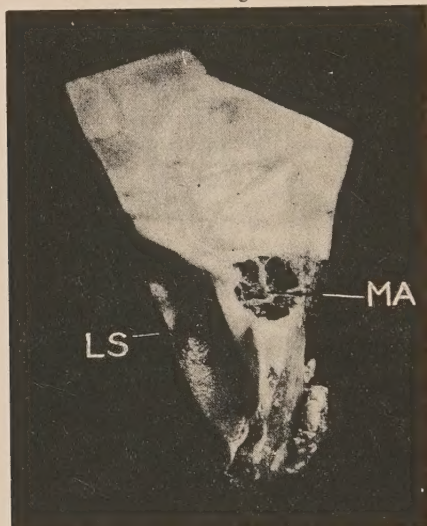


A photograph of a temporal bone, in the moist state, about one inch from the tympanic cavity. A section of the Eustachian tube is shown at the end of the line E T. It is a mere slit here, yet it becomes still smaller towards its tympanic end. The oval cartilage, which practically surrounds the tube, can be recognised.

tory swelling is capable of obstructing a tube of such a small calibre and thus preventing tympanic drainage. The secretion of the tympanic mucosa (much more abundant under these inflammatory than under

normal conditions) unable to escape through the Eustachian tube on account of its obstruction, accumulates and provides a warm fluid medium favourable for the rapid multiplication of microbes, some of which are to be found in every healthy ear. Ultimately it fills the middle-ear, including, of course, its hinder portion—the rough-walled, terminal cul-de-sac (Fig. 3) known as the mastoid antrum, which is the

FIG. 3.



A photograph of a portion of the temporal bone. The roof of the mastoid antrum has been removed in order to show MA, the rough wall of the back part of the cavity. LS points to the lateral sulcus or groove for the lateral sinus; its dangerous proximity to the mastoid antrum, so often the seat of suppuration, is obvious.

chief accessory sinus or "appendix" of the middle-ear. There is often no arrest of this profuse inflammatory secretion of fluid until the pressure in the middle-ear has risen to such an extent as to compress the capillaries of the thin mucosa, and thus arrest the circulation of blood within them. Two further effects usually follow on the augmented pressure—pain from compression of the nerves in the tympanic and attic mucosa, and finally erosion and perforation of the drum-head (Fig. 4). The new exit thus provided permits of the escape externally of the tensely pent-up fluid.

A large majority of these burst or "perforated" drum-heads heal rapidly, some of them within a day or two, without any treatment whatever. Others, which if left alone would likewise recover spon-

taneously, do so while the external auditory meatus is being systematically treated by means of syringing and powders. These superficial meatal cleansings, however, cannot honestly be regarded as a rational and really effective treatment of such a deeply-seated disease as this is, for the whole of the middle-ear is involved and the vulnerable walls of the

FIG. 4.



A portion of a right temporal bone in the moist state, showing the inner surface of the drum-head (*membrana tympani*). The handle of the hammer can be seen attached to the membrane, across the upper part of which the *chorda tympani* nerve can be observed to pass.

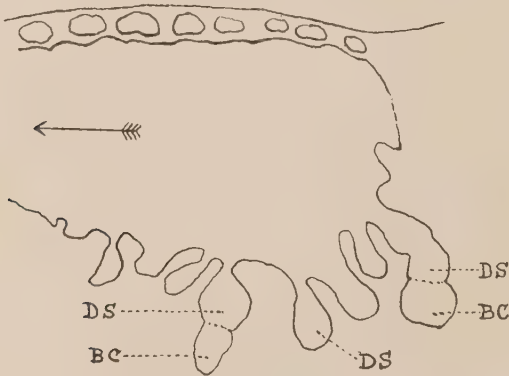
mastoid antrum, much higher up the stream and quite beyond reach of this treatment, are the only parts likely to be seriously affected. So the cures which occur in four out of five of these cases, whether the ear be syringed or not, are attributable to Nature and not to the syringe*. In the fifth case Nature's healing

* To anyone conversant with the pathology of this disease it would seem superfluous to condemn the custom of syringing the external auditory meatus under the mistaken belief that the chief seat of the disease (the mastoid antrum) is being treated thereby. Yet condemnation is still necessary, and will be for a long time, because syringing is still ordered and practised in thousands of cases every day. It is only by perpetually emphasising its absurdity that this humbugging, camouflage, do-something-however-futile treatment will in time come to be regarded in its true light. Plain speaking is necessary. It is a very serious matter for the country. The School Medical Officer of the London County Council reports that over 12,000 school children have a chronic aural discharge, and that 800 die every year from aural disease (1 in 16). The ears of all these children have to be syringed daily in order that the foul smell they give off shall not annoy the others in the classes. Many of their mothers,

processes are inadequate ; the disease persists, and is then called chronic. This is the case which needs the surgeon before the hearing is damaged.

The pathological conditions which are responsible for the persistence of suppuration in an ear which has recently been the seat of acute inflammation are most frequently to be found in some bottle-shaped offshoot (daughter sinus, Fig. 5) of the mastoid antrum, the orifice or neck of

FIG. 5.



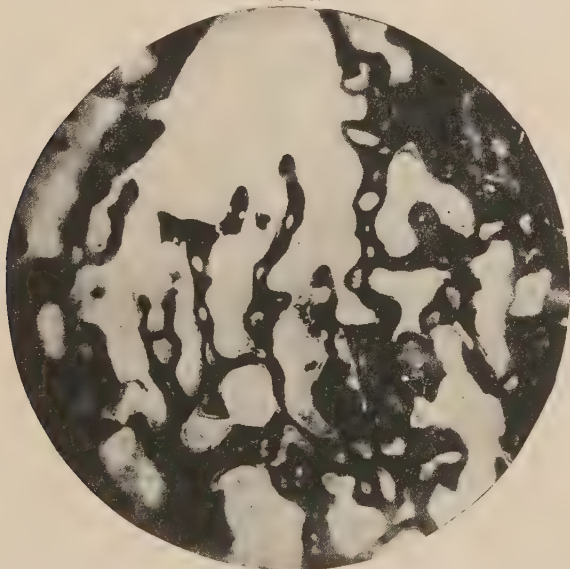
A diagram (enlarged) of the mastoid antrum. The arrow points towards the aditus and attic, the direction in which the cavity drains. DS = Daughter sinus (the chief sinus being the antrum itself). BC = Bone cell. The dotted lines separating the daughter sinuses from the bone cells represent fibrous membranes. The usual size of the antrum is shown in Fig. 1.

which is so small as to become obstructed by inflammatory swelling of its lining mucosa, or in some air-cell which happens to be situated close below the antral cavity (Fig. 6). In some cases these cells extend like

finding the syringing futile, cease to take their children to the Aural Centres to have it done. The result is that a number of people are employed to hunt them up and compel them to resume bringing their children to undergo a treatment which, after trying it for years, they know to be quite useless. The result of it all is a serious waste of life, hearing, time, and money. These ears need operations. Syringing does not cure. A large hospital and a trained staff are required. Is it not worth while to save 800 lives every year and thousands of ears? The surgeon who orders the urethra to be syringed because pus escapes through it from a diseased kidney far away is counselling treatment no more foolish or ineffective than he who orders the external auditory meatus to be syringed because of a persistent discharge from the ear. At the last International Otological Congress I brought forward a schedule which proved that this discharge is practically always due to mastoid disease ; it is therefore inaccessible by any but operative treatment. This Schedule is reproduced on pages 54 and 55.

a tail (caudal cells) or tassel behind and below the antrum as far as the tip of the mastoid process (see Fig. 1). In others they do not extend far. The latter, from their proximity to the antrum, might be named *satellite* air-cells. Sometimes these satellite cells are separated from the

FIG. 6.



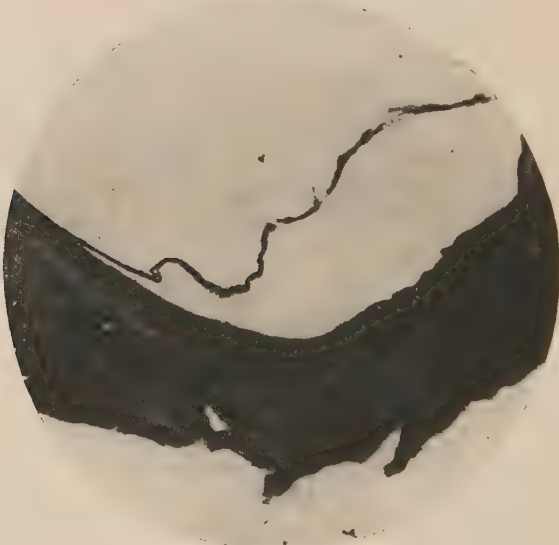
A microphotograph of a transverse vertical section through a mastoid antrum; the anfractuous structure of the floor of the cavity is shown, including daughter sinuses and satellite air-cells.

antrum by a frail fibrous partition, occasionally incomplete (Fig. 5), upon which rests the extremely thin antral lining. In addition to being thin, this lining is far less capable of vascular defence than that which covers and protects the neighbouring and much smoother* walls of the aditus, attic, and tympanum (Figs. 1 and 25). Seeing, then, that the lining of the rough-walled antrum is thin and often wholly incapable of defending the subjacent cancellous bone by becoming thicker

* Nature provides no vascular and protective mucosa in the middle-ear unless there is suitable accommodation for it—that is, a smooth surface for it to rest upon, such as obtains in the walls of the tympanum, attic, and aditus. The antral cavity, being usually rough-walled, is not thus covered; it is consequently the most vulnerable part of the middle-ear. The rapidity with which a really defensive mucosa will swell and protect the bone it covers is remarkable: within twenty-four hours of the commencement of its irritation by retained septic-mucus it may increase twenty or thirty fold in thickness (see Fig. 15, p. 29).

and vascular, and further that parts of the antral walls are not infrequently composed of mere frail fibrous membranes (Figs. 5 and 6), it is not surprising that these weak portions should occasionally yield before the high pressure to which they are often exposed in otitis media ere relief is afforded by rupture or incision of the drum-head. This yielding allows of the entrance into neighbouring pneumatic cells of some of the septic antro-tympanic secretion. Now, these air-cells (pneumatic cells) (Fig. 7)

FIG. 7.



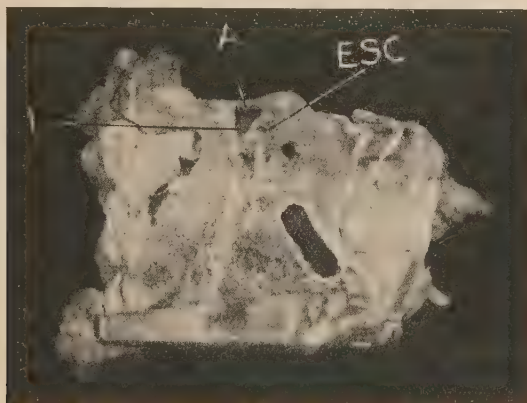
A microphotograph of part of a pneumatic cell (mastoid area).
It shows partial detachment of its lining.

are also devoid of a vascular mucous lining, active both in defence and repair, such as uniformly protects the smooth, bony walls of the tympanum, attic, and aditus. Like the rough-walled antrum, they are lined with little more than a single layer of endothelium; their defensive and reparative power is therefore much less than the before-mentioned smooth-walled, mucosa-covered parts of the ear (Fig. 1). Consequently, when septic secretion is forced into them, their weakly-defended bony walls become damaged, and once damaged some of them are liable to remain permanently so.

When septic disease has been established in any of the natural recesses draining into the mastoid antrum (daughter sinuses, Figs. 5 and 6), or in any of the adjacent bone-cells, the affected parts give off some-

septic discharge, for the exit of which a drainage channel is required. As the natural and only available channel of escape is through the antrum (the way the disease found entrance) and the narrow channels of the aditus (Fig. 8) and the attic to the tympanum, and thence through the

FIG. 8.



A transverse vertical section of the left temporal bone; the section passes through the aditus immediately behind the incus (viewed from behind). The triangular channel of the aditus A is wide above and narrow below. The top or hog's back of the incus (I) can just be seen through the opening. The external semi-circular canal (E S C), in its dangerous proximity to the drainage-floor of the aditus, are well shown. Along this floor the septic discharge from the mastoid antrum passes in cases of aural suppuration. In chronic cases the disease often destroys the mucous membrane and the bone, thus opening the canal and causing meningitis.

perforation*, it is reasonable to expect that the mucous membrane lining this route should become irritated by contact with the septic discharge during its outward passage. That is precisely what occurs. Changes due to this irritation, in early cases always attended by redness and swelling of the mucosa-lined portions of the route (the aditus, attic, and tympanum), therefore take place. Presently I propose to point out the situations where this swelling is most important, because of its liability to interfere with drainage and impair the hearing, and the signs whereby its presence and degree may be known. For unless there be early recognition of the existence of this obstruc-

* A roundabout passage, certain parts of which are narrow, and therefore liable to become obstructed by swelling of the mucous lining.

tive swelling, as well as appreciation of its great importance, effective treatment of the disease in the antral walls is liable to be delayed until some of the essential tympanic structures are destroyed or their mobility permanently impaired, and the patient thus made deaf for life—in other words, disabled through lack of appropriate surgical assistance, which should have been rendered as soon as the tympanic mechanism is observed to be in jeopardy—that is to say, when its function is obviously impeded. When any single member of the many important structures in the tympanum is seriously injured by disease, hearing often cannot be restored. Irreparable damage, however, would rarely occur if the weak-walled accessory sinus, known as the mastoid antrum, which in early cases is usually responsible for the persistence of aural suppuration, were promptly and suitably treated. Treatment so irrational*, and so frequently terminating in the loss of hearing, as that which has hitherto been recommended in the text-books, can no longer be tolerated.

My experience has clearly proved that when aural suppuration is rationally and promptly treated the heavy mortality (see Schedule, pp. 54 and 55), and enormous loss of hearing, which otherwise result from it, are almost entirely prevented. If we are to provide in this way for the whole of the community, then at least ten times as many aural surgeons would be required as are now available.

There are two important factors which participate in controlling the course of a case of otitis media, and require consideration when we are estimating the probability of spontaneous recovery in any individual case. These are: The vascular supply and drainage facilities of the parts chiefly responsible for the persistence of disease, viz., the mastoid antrum and its offshoots (the daughter sinuses which drain into it and comprise its watershed—Fig. 9), and the satellite air cells.

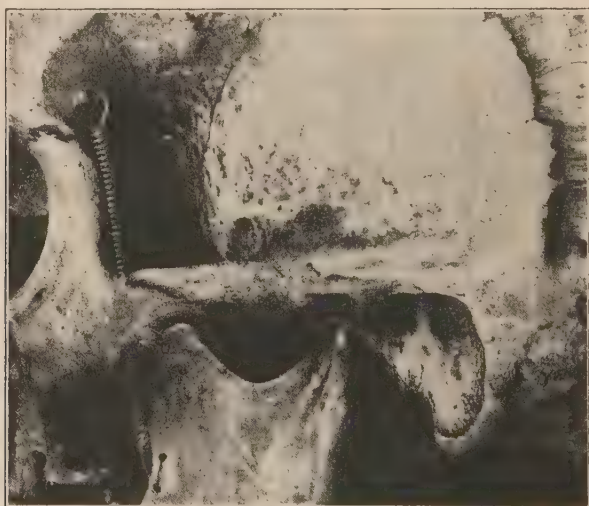
Experience has shown that a wound, even if septic, can usually be left to Nature's cure if its drainage be free and its blood supply abundant, and that irritation usually persists as long as drainage is retarded. In chronic aural suppuration these obstacles to repair usually co-exist,

* Appendicitis may now and then be cured by Nature. Mastoid disease (*i.e.*, aural appendicitis, for the antrum is the appendix of the ear) may also be cured by Nature's efforts. Yet one may as well expect an enema to cure appendicitis as to anticipate that syringing the external auditory meatus and inserting drops or powders will cure, or even reach, the mastoid disease, which is the cause of a persistent discharge from an ear. In neither of these examples does the application reach the disease, and, even if it did, it would not cure it. When the antral walls are unaffected the ear not only gets well, but does so quickly, because all the rest of the middle-ear channel is covered with a vascular defensive mucosa possessed of great reparative power.

apart, as though it had a pathology peculiar to itself. The results have proved disastrous.

During operations on cases of chronic aural suppuration some part of the walls or tributaries of the mastoid antrum is invariably found to be diseased (see the Schedule on pp. 54 and 55), yet at operation the cavity usually proves to be empty, unless the drainage has recently become completely obstructed and the disease is thus becoming acute. Some portion of the rough and irregular bony walls of this cavity remains diseased, in spite of its being drained. One of the reasons for this is that when the thin lining has been penetrated and the

FIG. 10.



A portion of the left side of a skull, showing the extent to which the diseased bone is usually removed in the writer's conservative mastoid operation. The dark aperture on the left is the meatus; behind that the "bridge of bone" is shown, and behind that the antrum can just be seen; it comprises the upper end of the large cavity in the bone.

subjacent cancellous bone infected by the pressure of septic mucus, before relief is afforded by perforation or incision of the drum-head, the nature of its non-vascular bony surroundings (*pars petrosa*) and its deficient innervation* do not ensure its receiving enough blood for the

* In the *Lancet* in 1906 I pointed out that the antrum is a cavity usually having remarkably little sensibility, and that considerable pressure may exist within it and cause extensive destruction of its bony walls, without giving rise to much, or indeed any, pain; fever, also, is occasionally absent in acute mastoid disease.

needs of repair. This lack of blood supply is partly due to lack of elasticity in the local vascular arrangements (the *pars petrosa* consisting of dense, unyielding bone, and the blood-vessels being endowed with but little muscular and elastic tissue), and partly to scanty innervation of the cavity, and consequent deficiency in neuro-vascular protective and reparative response to local septic irritation.

Though the admonition should scarcely be required in these days, when the importance of the drainage of septic areas is widely appreciated, it is still necessary to assert, in season and out of season, that the painful pressure (ear-ache) caused by the acute distention of the tympanum with septic mucus should, with very few, if any, exceptions, be relieved within an hour or two by an incision of the drum-head.* This should be done with the twofold object, first, of giving relief from pain and, secondly, of preventing injury to the weakly-defended antral walls through the pressure of the pent-up septic secretions. Suppose, in a case in which the drum-head has been incised too late or in which its spontaneous rupture has taken place, the ear nevertheless continues to discharge for weeks, I contend that *the walls of the mastoid antrum should be regarded as involved in the disease* (i.e., *mastoid disease*), *for at operations, however early or late they may have been performed, I have never yet failed to find it so*, and at the last International Otological Congress (see Transactions) I gave abundant proof of the apparently universal implication of this cavity, both in acute and chronic disease, by bringing forward a record of 739 consecutive cases (360 my own at the Throat Hospital) scrutinized during operations by six surgeons, in which mastoid disease was identified in every case (see the Schedule on pp. 54 and 55). Surely this is proof enough that the antrum is the chief seat of the disease and the essential cause of its persistence.† Yet other evidence of antral responsi-

* This is only possible if ear hospitals are accessible, and competent resident surgeons always available.

† Having proved that the antrum is the fountain-head—the real source—of the disease and the cause of its persistence, I must again call attention to the futility of the prevailing treatment, viz., syringing the external auditory meatus lower down the stream. This treatment, though still orthodox and recommended in the books, is just as foolish as attempting to purify a river by throwing antiseptics into it three times a day, while every moment it is being polluted by the sewage of a town a mile higher up the stream. What would we say of a Sanitary Officer who acted in this way? The aural surgeon, who does practically the same thing when ordering treatment of the meatus, because it transmits a discharge originating higher up the stream (in the mastoid antrum) is not condemned, as he ought to be, but recompensed for his foolish work. Dr. Sohler Bryant, U.S.A., has very properly pointed out the failure of the aural treatment in the present war, and the editor of the *Journal of*

bility for the persistence of disease will presently be adduced, viz., the results of operations *upon this cavity alone, the effect being the cure of the whole of the disease that previously existed in the attic and tympanum*. Where, in the records of surgery, are two more conclusive proofs than these to be found ?

Nature has only one method of defence against the innumerable forms of sepsis which infect the ear ; one involving swelling of the mucous membrane which lines the smooth-walled parts of the cavity. This swelling is required in order to accommodate an increased supply of blood. Increased vascularity is in itself some defence, but in addition it brings with it defensive and offensive cells. The degree of swelling of the mucosa, as indicated by such symptoms as pain, deafness, vertigo (for the swelling being inside the drum-head cannot be seen), I have found to be the most reliable early guide as to the extent of the difficulties Nature has to contend with in the diseased ear, and the need of the surgeon's assistance. The greater the irritation produced by the passage through the ear of the septic antral discharge, the greater becomes the natural defensive swelling of the mucosa (in

Larynxology and Otology drew attention to his letter in the November issue in these words : " That of all the different varieties of medical organisation in the armies of the English-speaking Allies, that of otology is the weakest." He is right ; it is not only the weakest, but much of it is a positive disgrace to modern surgery, and, as I show in this pamphlet, has no pathological foundation. A very large number of men suffering from mastoid disease (incurable except by operation) in Army hospitals or attending Army Aural Centres are merely having their ears syringed daily and drops put in. If this kind of thing is to go on until the discharge stops some of them will die of the disease, and a large proportion of the remainder will not be fighting in this war, even if it lasts ten years ; it is a sheer waste of time and money. As a proof of the inadequacy of the prevailing treatment, I may mention that a comparatively young practitioner, now surgeon at one of the General Hospitals in London, and formerly surgeon at a London Ear Hospital, recently informed me that " he had given up ear work and taken to general surgery because the treatment of ear disease was so disappointing ; he could neither prevent nor cure deafness." Such an unusual proceeding on the part of an able young surgeon, entailing as it did the surrender of a post which had probably taken him years to secure, as well as a complete change in his studies and work, was not lightly undertaken, and speaks more convincingly than any words of mine. For, though he might have got a living out of otological practice, the result of his work could bring him no satisfaction. His action is a far more serious indictment of the prevailing otological teaching and practice than anything I can say, and few will assert that I have been sparing in my criticisms. This is too serious a matter to be lightly treated. Yet the teaching this surgeon by his action so forcibly condemns is passing muster daily as the best. His opinion of the prevailing otological procedure conforms with a statement I have

the aditus, attic, and tympanum), for Nature rarely does anything superfluous, and her defence may be so vigorous that the resulting swelling in the attic portion of the passage may, and often does, obstruct the drainage from the antrum. The condition then is one of acute mastoiditis, and is usually dangerous to life. In such a case the successful defence (through swelling) of one part (the attic) leads to obstructed drainage from and disaster in another (the mastoid antrum).

The course of a case of otitis media does not necessarily depend on the nature of the predominating infection. No matter whether the discharge contain streptococci, staphylococci, pneumococci, or others, if the attic be roomy and the antral drainage free, the ear may recover spontaneously provided the antrum be not seriously involved. If, on the other hand, the attic passage be small and the antral drainage consequently impeded by swollen mucosa, recovery is improbable, whatever be the nature of the infection.

A factor which usually appears to have a far larger influence on the subsequent progress of a case than the nature of the chief infecting microbe is the amount of resistance to perforation offered by the drum-head (Fig. 4) under the pressure of the pent-up secretion within the middle-ear. It is the amount of this resistance which regulates the duration, degree of pressure in the ear, and consequent damage which

often made, viz., that the results of the prevailing treatment of diseased ears do not justify the faith of the community.

The surgeon of another London Ear Hospital said to me, not long ago, "I do not bother about the hearing in cases of aural suppuration." Surely a remarkable confession! Yet it is an example of the prevailing casual attitude, and appears to have resulted from repeated failure. It is an attitude against which I have for years contended, because the inaction it entails permits the disease to continue unchecked, and thus to destroy the hearing.

To push this matter, however, to its logical conclusion: if the hearing is not worth bothering about when caused by aural suppuration, why "bother about" it when caused by something else? And why are hospitals established to cure disease of the ear? And why are there aural surgeons at all? Really, it is time to cease trifling with ear diseases: they must be treated seriously, and the possession of good hearing be regarded, not as of little account, but as one of the most valuable possessions of a young man or woman in the battle of life.

Old customs and traditions die hard, and the present toleration, or neglect, of aural suppuration, is a survival of the days when mastoid operations were more fatal than the disease they were designed to cure. They were therefore delayed too long, and were consequently ineffective. A bad reputation was the result; it has hitherto persisted, though the statistics in the Schedule, pp. 54 and 55, show that of late an improved technique has removed the reproach.

may occur, especially in the defenceless antrum*, prior to the advent of the relief afforded by incision or rupture of the obstinate membrane (drum-head) and exit of the pent-up secretions. Great diversity in this respect is exhibited by different ears. Some drum-heads are thin and become perforated in an hour or two under pressure so slight that the patient scarcely feels, and sometimes does not feel, any pain, the perforation occurring during sleep. In these cases of slight pressure injury to the antral walls is rare, and repair is often complete within a few

FIG. 11.



The cross marks the usual site of the mastoid antrum ; the cavity is about one inch from the skin.

hours, or at most days. In neglected cases days, or even weeks, of pain may elapse before a tough and vascular drum-head becomes so softened by the combined effects of pressure, consequent anæmia, and bacterial attack, as to rupture and give exit to the pent-up fluid within.

Numerous observations, made before and during practically bloodless mastoid operations, have convinced me that the whole middle-ear space normally occupied by air, including, of course, the mastoid

* Disease in the antrum—that is, mastoid disease—is practically the sole cause of the persistence of a discharge from the ear. It can usually be prevented by prompt incision of the drum-head after the ear has begun to ache. We therefore want ear surgeons and ear hospitals in all populous localities, so that expert help shall be always available in this way to prevent deafness in the rising generation.

antrum and its offshoots, is usually filled with fluid secretion for a time varying from hours to weeks before there is pressure enough to cause pain, or to stretch, soften, and perforate the drum-head. The stronger the resistance to perforation which this membrane offers, the greater becomes the pressure in the middle-ear, and the greater also the liability to the establishment of disease in the weakly-defended antral walls, which, by giving rise to a *persistent* irritating discharge (which has to find an outlet through the tympanum), leads finally to deafness through irreparable injury to some essential part of the tympanic apparatus.

The great question is : When is the tympanic hearing apparatus in such jeopardy as to justify the conservative mastoid operation? In other words, what are the reliable tympanic symptoms which call for operative intervention in order to save the hearing? We must judge from the symptoms, because we cannot see much, if anything, of what is going on inside the drum-head. The answer is a somewhat long one, yet simple withal.

Before giving it, however, I must describe in some detail the position and importance of the swelling of the tympanic mucosa already referred to, as it is present, more or less, in every case of aural suppuration, and is usually most marked in the early ones. It is these I am now considering, because treatment must not only be early : it must also be effective enough to arrest the disease, if the hearing is to be uniformly preserved ; and if it is not to be preserved no *aural* surgeons are required. The present happy-go-lucky custom (resulting from inadequate teaching by the books) of making no diagnosis of the various tympanic conditions present in different cases, and treating all alike, viz., by the persistent syringing and instillation of drops into the external auditory meatus, where they are wholly out of reach of the chief disease high up in the distant antrum—a procedure which amounts to letting the ear “take its chance”—is both unreasonable and dangerous, for only those cases recover which would do so if left alone, whereas the delay in real treatment results in the loss of hearing in the remaining cases and the lives of some. Discharging ears should be systematically examined and tested every day and the observations recorded on a chart.* If the chart shows that the disease is progressive or even persistent (for persistent suppuration will damage the hearing), deafness should be prevented by a mastoid operation on the lines instituted by me in 1906 (the *Lancet*) and named “the con-

* Three typical charts will be found at the end.

servative" method, inasmuch as it was devised for the purpose of conserving the hearing, whereas the operations until then in use were not.*

In otitis media the whole of the mucous membrane lining the smooth-walled portion of the middle-ear channel (*i.e.*, the aditus, attic, and tympanum) is inflamed and more or less swollen; nevertheless, for convenience of description, I propose to map out the swollen regions into areas corresponding to well-defined parts of the cavity. As these areas, or masses of swollen mucosa may obstruct drainage, I speak of them as "dams." Each one of them has an important effect and significance, and though they are hidden from view I hope to prove that the presence of each can be definitely recognised by a discriminating observation of the symptoms to which it gives rise.

The first, the Eustachian dam (Fig. 12 B), is formed by swelling of the mucous membrane lining the Eustachian tube near its narrowest part—the isthmus. This dam more often completely obstructs the passage it occupies than either of the two others presently to be described; and without complete obstruction of the Eustachian tube the tympanic secretion will, of course, escape through it to the nose, as in health. When this dam is complete and relief is not afforded by incising the drum-head, the increasing intra-tympanic pressure resulting from the gradual accumulation of secretion usually causes perforation of some part of the lower (tense) portion of the drum-head. The existence of this dam is easily recognised by its preventing the passage of air through the Eustachian tube to the tympanum, when forced by Valsalva's or other method of inflation. Further, when present it will prevent any lotion which is forced into the tympanum through the meatus and the perforation from reaching the nose; and as lotions cannot pass along, it is also obvious that tympanic secretion cannot escape by this, its natural drainage route. It therefore escapes through the perforation and the meatus. This obstructing dam may persist for many years if a diseased mastoid antrum is giving off discharge which passes through the middle-ear and escapes through a perforated drum-head; yet, even so, it may be, and often is, *removed by Nature within a few hours of the arrest of mastoid and consequent tympanic disease by my method of mastoid operation.*† On the other hand, the swelling is

* Various and confusing are the names which have been given to my method of mastoid operation. "Conservative-radical" is one—a contradiction. "Modified radical" and "incomplete radical" are others; there are many more, and all unsuitable. I object to the use of the term *radical* with regard to the operation I devised, because in the radical operation the drum-head and small bones are removed; in mine these essential structures are preserved, and the hearing thereby saved.

† This I have observed hundreds of times.

occasionally slight and the dam incomplete. In such a case air can be forced into the tympanum from the nose, whence, if there be no tympanic obstruction to its further passage, it will escape through the

FIG. 12.



12 A.

An outline of the middle-ear, showing the rough walls of the mastoid antrum and the smooth walls of the remainder of the channel. The dotted line indicates the situation of the drum-head; it is shown with a small perforation in the postero-superior quadrant; a very common situation for the membrane to give way in otitis media.



12 B.

The Eustachian Dam; the cause of otitis media through its interference with the escape of the secretion of the middle-ear, which, even in health, is septic.



12 C.

The Tympanic Dam; the cause of deafness in *early* cases through its interference with the mobility of the drum-head and ossicles. The discharge from the mastoid antrum may escape, as here shown, through a perforation behind the dam.



12 D.

The Attic Dam; the cause of acute mastoiditis, on account of its obstructing the drainage from the mastoid antrum. The tympanic secretion, meanwhile, may, and usually does, escape through the perforation as here shown.

In these figures the red colour is used to indicate swelling of the mucous membrane. The parts affected are the Eustachian tube, the tympanum, the attic, and the aditus. The redness ends at the back of the aditus, where that cavity merges into the antrum, as the lining of the latter is usually thin and incapable of swelling.

perforation, usually accompanied by mucus in the form of bubbles, thus rendering the escape visible as well as audible to the examining surgeon.

The second is the tympanic dam (Fig. 12 C). The swelling of the mucosa in this instance varies in position according to the situation of the perforation, yet, like the Eustachian dam, when com-

plete, it prevents lotions which may have been forced into the tympanum through the meatus and the perforation, as well as the septic antral discharge, from passing downwards and forwards to the Eustachian tube and the nose. Occasionally this dam, while absent from the lower and front part of the tympanum in the neighbourhood of the Eustachian tube, is complete further back, near the perforation (as shown in the figure). In such a case the patient can blow air into the anterior part of the tympanum by Valsalva's method, and the surgeon, if observing at the moment, can see the membrane distend, yet none of this air escapes through the perforation in the form of bubbles, this being prevented by the complete (*i.e.*, air-tight) dam. If the swelling of which this dam is composed extends, as it usually does, far enough from the promontory to reach the drum-head, the handle of the hammer (only 1-32nd of an inch, about 1 mm. distant), or the descending limb of the anvil, it will interfere with the vibration of these structures and cause more or less deafness; thus the presence and approximate thickness of the dam at this point may be estimated, even if air can be forced by it from the Eustachian tube to the perforation.* The existence of this defensive dam proves that the septic antral discharge coming down through the attic to the tympanum has irritating qualities.

In 1907† I published cases which proved that these defensive dams, after having their presence demonstrated during operations, are thereafter rapidly removed by Nature, the protection they previously afforded being no longer required, inasmuch as the diseased antral walls having been eradicated by operation, the septic discharge which they had previously given off no longer passed through and irritated the tympanum—had, indeed, ceased to be formed.

The third is the attic dam (Fig. 12 D). Although the whole of the mucous membrane covering the walls of the attic channel is irritated by the passage of the septic antral discharge and is consequently swollen, the obstructing portion or dam is usually‡ formed by the swelling of that part of it which covers the smooth convex bone

* Unless the Eustachian tube is permeable the completeness or incompleteness (*i.e.*, permeability) of the tympanic dam cannot be demonstrated. In such a case an approximate estimate of its thickness can be made by observing the degree of deafness which it causes.

† The *Lancet*.

‡ When the aditus is very small swelling of its lining may produce a complete dam, and so cause acute mastoiditis. This condition is not common, as the aditus is usually considerably larger than the inner attic drainage route, and being so is less liable to become obstructed. The matter is of little importance; the symptoms and results are alike and the treatment required is the same in either case.

comprising the inner attic wall. The dam is situated on the inner side of, and usually in contact with, the smooth body of the anvil and head of the hammer. As the muco-periosteal covering of these bones is never swollen in early cases, it does not help to obstruct drainage. On removing the bony roof of the middle-ear in a sound recent specimen it will be seen (Fig. 13) that the secretion given off by the walls of every

FIG. 13.



A photograph (from above) of part of a temporal bone, in the moist state. The roof has been removed from the antrum, the aditus, and the attic. H points to the top of the head of the hammer, A to the anvil, T T to the tendon of the tensor tympani muscle passing outwards low down in the cavity to join the hammer, upon which it pulls in order to tighten the drum-head. S points to the stirrup. Situated deep down in the dark tympanic cavity, this bone can scarcely be seen. The line leading from the letter S

upwards to the stirrup passes over the rough-walled floor of the antrum, where the orifices of the "daughter sinuses" are plainly visible. (The diagram (Fig. 9) was taken from this bone, and fairly accurately depicts these daughter sinuses; they drain into the antrum.) Above the orifices of these sinuses the bone is smooth until the dark inner attic drainage route is reached; this smooth bone is the floor of the aditus. On the right of the dark drainage route the smooth inner attic wall is shown. The mucosa covering this wall swells in cases of otitis media and reaches to the hammer and anvil, and pressing against them comprises the attic dam. By referring to Fig. 15 it will be seen that this dam, when complete, may be much larger than the channel it obstructs, in which case its elasticity makes it adapt itself to the shape of the locality. The drainage channel shown in the above figure is about the average size. See Fig. 25—it is an enlarged photographic picture of the middle-ear structures shown somewhat indistinctly in Fig. 13.

healthy antrum and attic, naturally passes down to the tympanum inside the suspension-bridge of bones, *i.e.*, between the larger bones (the hammer and anvil) and the smooth inner attic wall*. In suppuration the antral discharge nearly always descends to the tympanum

* This drainage channel I named, in a communication to the last International Otological Congress, the "inner attic drainage route."

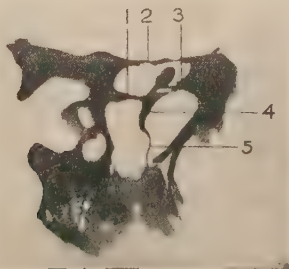
by the same narrow channel, travelling thence outwards below the bridge of bones, finally escaping through the perforation in the tense part of the drum-head.* When the drum-head, with the attached handle of the

* In about 3 per cent. of apparently (because pain may be slight) chronic cases of mastoid disease, the discharge forces for itself an entirely new channel outside the neck of the hammer, and escapes into the meatus by perforating Shrapnell's membrane, "the outer attic drainage route." (See the writer's contribution, Trans. 9th International Otolological Congress.) It does not descend into the tympanum at all, because an attic dam prevents it. This fortunate, though rare, restricted and forced exit of discharge relieves the patient for the time being from the dangers of acute mastoiditis. I have, however, seen many cases in which this narrow drainage route, after having been available for a short or long period, has become obstructed; acute mastoiditis has been the immediate result, because of the presence of the attic dam. In the books this "outer attic" route or drainage of the mastoid antrum has been misnamed "attic disease," in the erroneous belief that the attic alone is involved. I have always found the dangerous antrum diseased during operations on these cases. (*The Lancet*, April 27th, 1907). Chronic disease of this rare kind (3 per cent.) should be dealt with by the conservative mastoid operation much earlier than those of the prevailing type (97 per cent.) which drain downwards through the tympanum, for the following reasons: First, because a complete attic dam exists, obstructing the usual drainage route to the tympanum, a condition fraught with danger to the hearing apparatus, if not immediately to life. Secondly, because the "outer attic" drainage route (in the small percentage of cases in which it can be made available) is often dangerously small—less than a pin-hole; it is therefore very liable to be obstructed, as already explained. Thirdly, because in part of this newly forced route the bone is not protected by mucous membrane; consequently caries and polypoid granulations occur with unusual frequency. Fourthly, because the lack of the transmitting power of ciliated epithelium in the part of this narrow route (where there is no mucosa) leads to the accumulation of squamous cells, *i.e.*, cholesteatoma by accumulation or filtration. (See the writer's contribution to the 9th Intl. Otol. Congress on early cholesteatomatous accumulations).

Relatively, and for the reasons just enumerated, a far larger number of the discharging ears with the perforations in Shrapnell's (loose) membrane become deaf than of those in which the discharge escapes down to the tympanum and thence through a perforation in the tense or tympanic part of the drum-head. Of the latter kind about 80 per cent. recover spontaneously before any permanent damage has been done to the hearing apparatus, whereas of those with a perforation in Shrapnell's membrane more than 90 per cent. will surely suffer from deafness unless a conservative mastoid operation is promptly performed. Even then it may be discovered during the operation that the removal of the "bridge" is also required in order to provide access to the obstructed attic for the purpose of removing the septic and profoundly irritating cholesteatomatous accumulations, which occasionally cover the projecting upper parts of the bones (hammer and anvil). This is the only way to eradicate the disease and save the hearing, whenever foolish and undue delay in resorting to the conservative mastoid operation has given time for the accumulation of squamous cells to form an attic cholesteatoma.

hammer, vibrates to sounds, this "suspension-bridge" rotates,* to a limited extent, on the two points of its suspension (see Figs. 1 and 9). It is composed of the anterior ligament, the neck and head of the hammer, the interosseous ligaments, the body of the anvil with its short process, and the terminal joint attachments of the latter. This suspension-bridge of bones rotates because it cannot swing, swinging being prevented by the external ligament of the hammer which acts as a stay. While the limited amount of bridge rotation which this ligament permits is taking place in response to the impact of sound-waves against the drum-head, the heavy head of the hammer (Fig. 14) and the ponderous upper part of the body of the anvil, in my opinion, serve to facilitate the movements of the long descending limbs of these bones, by acting as balance-weights. These heavy balancing weights are required (and to me appear to offer the only explanation of the exceptional design of these bones) because the tympanic mechanism is somewhat akin to a high-speed single cylinder engine, the movements of which, as the engineers have discovered, are facilitated by the utilisation of balance-weights. Here again Nature has forestalled the engineer, and in the tympanic apparatus has

FIG. 14.



A transverse vertical section through the attic and tympanum. By good fortune it was carried through the tendon of the tensor tympani (1) and the external ligament of the hammer (3). It shows the heavy head of the hammer (the balance weight) free in the attic and the lower part of the bone (4) in the tympanum; extending downwards from its lower end to be attached to the tympanic ring the section of the lower half of the drum-head (5) can be seen, as a thin wavy line. The frail bone (2), which forms the roof of the attic, is the sole barrier between the air in the ear and the cranial cavity. This is a dangerous state of affairs when the ear becomes filled with septic fluid, under pressure, as in otitis media, before rupture or incision of the drum-head brings relief.

* Like other suspension-bridges, this one is supported at its ends only, and merely stayed in the middle to prevent it from swinging.

provided a wonderfully efficient mechanism for facilitating the movement of the drum-head and bones and thus the transmission of sound. This the engineer would appreciate and protect; whereas the surgeon, in consequence of his inadequate mechanical training or in deference to the disastrous "wait-and-see" teaching of the books, allows mastoid suppuration to persist until some part of the elaborate mechanism is irreparably damaged and the patient rendered permanently deaf.*

The attic dam is the usual cause of acute mastoiditis. This it brings about by obstructing drainage from the attic and antrum. When using the air-and-lotion bag with the aditus cannula, as part of the technique of the conservative mastoid operation, upon these acute cases, it is often found to be impossible to force either air or lotion past this dam to the perforation; yet within 48 hours, when the first complete post-operative dressing is undertaken, air can usually be blown through with the same bag and cannula, and the patient can also blow air in the other direction, by Valsalva's method, this clearance proving that Nature, assisted by the surgeon, has removed the obstruction.

* The study of the mechanism of the tympanic cavity, or middle-ear, as an engineering proposition, reveals many matters of interest to the mechanical engineer. In the tympanum he will find that Nature has forestalled, and still surpasses, his efforts to solve a problem—the transmission of power with a minimum of loss—that is, with a maximum of efficiency. In that cavity he can observe the equivalent of a *cardan shaft*, with its *universal joints*, interposed for the purpose of compensating, as far as possible, for the necessary physiological variations in *alignment*, thus diminishing friction and consequent *loss of power*. There are to be found the earliest examples of *light reciprocating parts*, such as engineers have found necessary, and therefore adopted, in modern high-speed engines, with the object of *diminishing the loss of power*. There, too, is to be observed the most *sensitive* and most efficient system of *governing* (reflex muscular), with *governors* controlling the mechanism at each end, *i.e.*, where the power is received from the air (the drum-head) and where it is utilised (the oval window of the labyrinth). Governing so complete and sensitive permits of that instantaneous *acceleration* which is the very essence of the *flexibility* of an engine. In the tympanum again is to be found the most complete *lubricating system* ever devised, the *viscosity* of the lubricant in each case being automatically adapted to the *bearing*, *fed* as required, and made on the spot. Not only are the hidden joints or *bearings* suitably lubricated, but the outer surfaces of the flexible ligaments are rendered more flexible by lubrication, by moisture; and, to ensure *economy of lubricant*, the tympanum itself is constituted as, and is the first example of, an *enclosed crank-chamber*. In addition, this chamber is provided with a moist atmosphere, thus ensuring the *surface lubrication* of every part within its walls which does not provide its own: the effect of this arrangement is similar to that of a modern *splash lubrication*. Part of this elaborate and efficient lubricating system, *i.e.*, the surface moisture, is deranged by a change in the character of the lubricant

Being economical of effort she has removed it, because active defence in that locality is not needed, inasmuch as the operation, by reducing the antral discharge and allowing what little there is during convalescence to escape by another route, the defensively swollen attic mucosa, being no longer irritated, rapidly reverts to a healthy condition. The prompt removal by Nature of the attic dam, after the antral walls have been removed by operation, clearly demonstrates that the chief disease must be in the antrum, and that the attic trouble is secondary to and dependent on it, for it is cured by treatment of the antrum alone.

When there is a discharging ear of recent onset, accompanied by persistent pain (with no meatal condition to account for the pain), there is usually—nay, practically always—retention of fluid in the mastoid antrum, owing to the presence of a complete attic dam. This condition is acute mastoiditis, and thus it should be named and treated. The swelling composing this important dam, when far reaching and extending downwards towards the tympanum, is liable to cause giddiness (vertigo) by putting unusual and erratic strain on the attachments of the stirrup. In every case of otitis media in which the mucosa is swollen enough to reach from the promontory to the drum-head, to the malleus, or even to the

through suppuration of mucous membrane, causing increase in the *viscosity*, *i.e.*, *visciditv*, of the lubricating mucus. Friction is consequently increased, mobility is correspondingly diminished, power is thus lost in transmission, and proportionate deafness results. Removal of the drum-head during the radical mastoid operation permits of evaporation of the surface lubricant; this leads to desiccation of the mucous membrane and diminution of its elasticity: the result is loss of power, and therefore of hearing. When devising my method of mastoid operation these facts came into consideration, the drum-head was consequently retained, loss of elasticity through evaporation of lubricant thereby prevented, and the hearing therefore preserved. As the tympanum is so constituted as to require moist air within and sound without for its efficient working, Nature has made suitable provision and placed it where each has access; no alternating tidal currents of air, such as must pass through the breathing channels, however, are possible in this cul-de-sac, consequently loss of power (*i.e.*, of hearing) through evaporation of lubricant, is prevented. If the power (or sound vibration) which is received by the drum-head from the vibrating atmosphere is diminished, or lost, during its transit to the labyrinth (the only place in which it can be utilised) then deafness must result. The transmission of power without loss is *still one of the great problems* of engineering; it is the *greatest of all the problems of otology*, because *nearly all deafness is due to loss of power in transmission*—in other words, to *obstacles to accommodation*, that is, to the *regulated and easy passage of sound vibrations along the chain of bones and membranes within the tympanum or middle-ear, to the labyrinth*—for the latter is very rarely at fault and may be regarded as the retina of the ear; accommodation being the function of the tympanic mechanism, and, like defective sight, *defective hearing is most often due to defective accommodation*.

incus alone, especially its long descending limb, the mechanical pressure of the mucosa prevents ossicular vibration to sound, and is almost the sole cause of the deafness which so regularly occurs in early cases; that is, deafness which did not previously exist—some patients being deaf from other causes, before suffering from this disease. Just as the Eustachian dam prevents the pent-up tympanic secretion from escaping, and leads to bursting of the outer wall of the tympanum (drum-head), in like manner the attic dam, by preventing the escape of the antral discharge, leads often to perforation of the outer (in this case bony) wall of the cavity and the escape of pus towards the surface.

All these dams are obviously more or less in continuity, because the middle-ear is a short and very small channel, and in this affection the whole defensive mucosa is swollen. Nevertheless, the existence of these various dams can be identified, and their effects demonstrated, in the manner I have described. Further, as the size of the middle-ear differs greatly in different individuals, the capacity to accommodate the swollen mucosa must also vary considerably; consequently the degree of it which will dam up and completely obstruct the drainage through a small attic (a complete dam), and thus lead to acute mastoiditis, may not be enough to occlude a large attic (an incomplete dam); in the latter case the discharge will escape and the disease will remain chronic. The relative size (the completeness or incompleteness) of the attic dam to the attic channel is the great factor which decides whether the disease is to be acute or chronic.* It consequently follows that similar infections may not lead to similar results in the large and the small middle-ears, and that bacterial findings alone are unreliable guides as to treatment or prognosis.

In youth the tympanic mucous membrane appears to be more susceptible to irritation and more vigorous in defensive swelling than in later years. Hence these dams, or rather the acute and other symptoms which they cause, are more frequently to be observed in the young,† though they do occur at all ages.

* My clinical experience and the pathological specimens in my collection go to show that a drainage channel through the swollen attic mucosa no larger than a horsehair (less than a quarter the size of a pin-hole) is far more than equal to the task of draining away the discharge from the antrum, and that with an unobstructed passage of this diminutive size the whole of the antral discharge will escape and the disease will not become acute. It will nevertheless persist in a chronic form, with a danger of acute mastoiditis arising the moment a slight increase of the swelling occurs and obstructs the tiny channel.

† With a drainage channel as minute as a horsehair, the disease may be acute and painful, as for instance in the morning, the attic channel being obstructed and fluid accumulating in the antrum under pressure, the pressure may rise and force the obstructive mucosa aside, so that the discharge

FIG. 15.



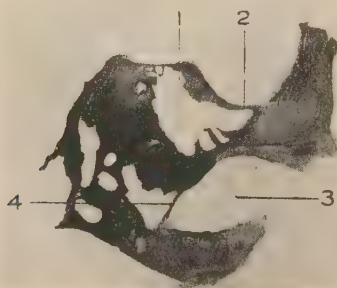
A photograph of a florin with a polypoid attic dam resting beside it. This dam was the cause of the onset of acute mastoiditis and was removed in the course of a conservative mastoid operation. Measurement of the coin and comparison with others will show that the items in the picture are not increased in size by the photograph, but somewhat diminished. It will easily be realised that swelling so abundant as this must be capable not only of obstructing drainage in the tiny passage, but of causing pressure against the ossicles and drum-head, thus interfering with their vibration and producing deafness. So rapidly and abundantly does swelling of the tympanic mucosa occasionally arise that complete inability to hear a watch by air conduction is often to be observed within a few hours of the commencement of pain in the ear, whether the drum-head has become perforated or not. The dam here illustrated is far larger than the inner attic drainage route in any bone in my possession, yet, being elastic, it adapted itself to the irregularities of the passage, and thus caused complete obstruction. Pain in the ear began, in this case, four days before the operation. On the third day the patient consulted me, and the drum-head was immediately incised. The resulting discharge was profuse and continuous, yet the pain persisted, so I operated next day. Pus was found in the mastoid antrum under pressure, being forced out when the cavity was opened. By the aid of the air-bag and aditus cannula this dam was blown partly out through the incision in the drum-head which had been made the previous day, and was then pulled out with forceps. After its removal air was again blown in through the aditus; it then escaped freely through the incision in the drum-head.

escapes in the afternoon, with cessation of pressure and pain. Such variations in the obstruction or permeability of the tiny drainage channel appear to be the usual explanation of the frequently recurring ear-aches of some children, whose ears meanwhile continue to discharge; for the tympanic discharge may, and usually does, continue to escape through the perforation, while the antral secretion is pent up and causing pain and danger to life.

It should be clearly understood that an accurate diagnosis of tympanic conditions can only be made in the early stages, because at this time the impairment of hearing is caused by obstacles to the mobility of structures which are practically intact, whereas when the disease is of long standing some part essential to the hearing may have become damaged or even destroyed.

These actively obstructive dams of vascular mucosa have far more influence on the progress of a case of aural suppuration than has the structure of the passive bone of the mastoid, for bone does not swell and obstruct drainage. It is the soft dam of œdematous mucous membrane alone which does this and is responsible for the loss of life which occasionally occurs during the early stages of this disease (Fig. 15). If pus, unable to escape on account of the existence of an obstructing (*i.e.*, complete) attic dam, be compressed in the antrum (Fig. 16), acute mastoiditis exists; and as the abscess is in close proximity to vital structures the patient is in danger. It matters not what class

FIG. 16.



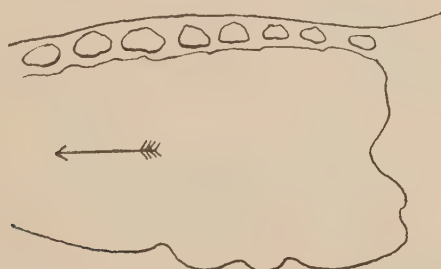
A section through part of a healthy temporal bone. 1 = the mastoid antrum; its rugged walls can be seen, also its dangerous proximity to the middle fossa of the brain, from which it is separated by the thin layer of bone (2). 3 = the external auditory meatus. 4 = the posterior part of the drum-head.

of bone the mastoid region is composed of, hard or soft, diploetic, cancellous, or what not, there should be no waiting in the orthodox, dangerous way for pus to bore through the bone to the surface, no dallying until X-rays are of use. The surgeon's duty is to give relief by opening and draining the septic antrum (the "aural appendix") without delay, just as the alert general surgeon, in abdominal appendicitis, promptly seeks his goal through the abdominal wall, whether his patients be fat or thin, muscular or spare, and does not wait for pus to reach

the surface. The prevailing custom of postponing operation in a case of acute mastoiditis until pus bores through the skull to the surface and causes a tenderness or swelling behind the ear is unjustifiable,* for it often travels more easily in the direction of the brain, or to the lateral sinus (Fig. 3), and kills the patient. Moreover, if the pus does travel to the surface, a mastoid operation is still required, and usually a larger and more dangerous one than would have sufficed if operative relief had been promptly afforded.

A complete attic dam is the most frequent—indeed, almost the sole—cause of the various early dangers associated with aural suppuration. Yet X-rays and transillumination fail to show it, and therefore do not help us. They may do even worse: they may

FIG. 17.



This figure should be compared with Fig. 5, p. 8.

* Some people, whose antral walls are smooth (Fig. 17), and consequently lined with a vascular bone-protecting mucosa like that of the tympanum, may suffer from acute mastoiditis for months without the occurrence of perforation, discharge or a post-aural swelling. I usually operate upon one such case every year. In acute cases of this, as of the commoner kind, the attic dam is complete, and prevents the antral discharge from reaching the tympanum; consequently incision of the drum-head gives no relief. Incision of Shrapnell's membrane may also fail to reach the fluid. In one of my cases of this kind the antrum only contained mucus: it was a mucocoele, and had obviously persisted for three months. The pain being referred either to the temporal region or the neck, acute mastoiditis was not suspected. This patient (a man) was sent to the seaside for six weeks; this did not help him. He was then sent into hospital for six weeks; this also proved useless. He was then brought to me, in an extremely weak state through the pain he had suffered. The symptoms then noted were: deafness, redness of Shrapnell's membrane, almost continuous pain (now referred to the ear), and loss of three stone in weight. I at once incised Shrapnell's membrane, for I knew that the tense part of the drum-head would have given way long before had the tympanum been distended; blood only escaped and the pain was but little relieved. Next day I performed a conservative mastoid operation and found a mucocoele tensely pent up in the antrum. Recovery was rapid and complete.

induce the surgeon who relies on their guidance to hold his hand when the tympanic or other clinical symptoms plainly call for relief by operation.*

At that early stage of chronic mastoid disease (this is its proper name, though it is often referred to as otitis media or chronic aural suppuration, names which convey no information as to the chief seat of the disease), when the conservative mastoid operation is called for, in order to save the hearing, skiagrams show nothing to indicate the need of operation, nor, as a rule, do they help us in the early stage of acute mastoiditis. Usually by the time a skiagraphic picture shows the need of an operation in acute disease, and often even before this, the patient and his friends realise that the condition is a serious one, and that the call for operation is urgent.

An active phagocytosis may prove unavailing if combined with abundant defensive swelling and a consequent massive (*i.e.*, a complete) attic dam. For the dam, by obstructing drainage, may cause acute mastoiditis and danger to life long before the phagocytes can do their work. Furthermore, acute mastoiditis may exist (*i.e.*, pus pent up under pressure in the antrum by a complete attic dam) without causing any fever whatever, and the microscope and X-rays may give no help in the diagnosis, though the estimation of the amount of hearing and the usual presence of pain will generally afford guidance. My experience

* I demonstrated the untrustworthiness of transillumination when operating, at the invitation of the President, before the last International Otological Congress (Boston, U.S.A., 1912). From my experience of the antral conditions found at operations on a great many cases with similar tympanic symptoms, I gave it as my opinion that a certain patient of Dr. Plummer's at the Massachusetts Eye and Ear Infirmary in Boston was suffering from disease of the mastoid antrum, and that the discharge this cavity gave off was responsible for the tympanic disease which I observed and described. This diagnosis called for a mastoid operation on the conservative lines I instituted (in 1906), in order to save the hearing. Dr. Harris P. Mosher, another member of the staff of the hospital, having transilluminated the affected ear, and founding his opinion on the result, demurred as to the need of operation. The patient was put back, yet detained in the hospital. A week later, when my arrangements were being made to go to Canada to take part in another Congress, Dr. Plummer again asked me about this patient. My reply was to the effect that I had already given my opinion as to the treatment required. He then decided that the operation should take place. Before it was performed Dr. Mosher again used the transilluminator, and again expressed the belief that an operation was unnecessary. The operation was performed, Dr. Mosher standing beside me. Not only was the mastoid antrum diseased, as I had stated, but it was filled with pus, and so were all the cancellous bone-spaces extending from that cavity to the tip of the mastoid process. Dr. Mosher, as was to be expected from one of his renown, made a handsome acknowledgment.

has also shown that until the pressure of the pent-up septic antral secretion has destroyed the protective cells on the surface of the mucoperiosteal lining of some part of that cavity, and enabled the septic mucus to reach and enter the subjacent lymphatics, and through them the blood stream, there is rarely any rise of temperature in cases of acute mastoiditis. Hence the supreme importance, in the case of a discharging ear, of the onset of pain (which implies pressure) as a sign of impending danger to life. In uncomplicated cases of acute mastoiditis the temperature is rarely above 100.5° , and in marked cases with extensive external swelling, displacement of the ear, profuse discharge and even necrosis of bone, there may be no rise of temperature and no pain whatever.

The action and reaction between the attic and tympanic dams and disease in the mastoid antrum (for the dams, more or less complete, are always maintained by Nature as long as the antrum is diseased and draining freely through the ear) are the cardinal features of almost all cases of aural suppuration, no matter whether they be acute or chronic. When the attic dam is complete,* and secretion which cannot escape causes acute distension of the antrum, there is a condition of acute mastoiditis, no matter whether the secretion remains pent up under high pressure in the cavity or whether it bursts through its bony walls and works its way towards the surface, the meatus, or the brain. If the disease in the antrum persists the resulting discharge will cause the attic and tympanic dams to persist, too, in greater or less degree, giving rise in every case to some deafness through interference with the mobility of the drum-head and ossicles.

* Some time ago a little boy, in North London, had an attack of influenza. This led to otitis media and perforation of the drum-head on both sides. The left ear, while discharging freely, became the seat of severe pain (as in Chart 3), and the temperature rose to 103° F. A specialist was called in; he advised waiting for a fortnight to see how matters developed. The family doctor, who considered the case very serious, then called me in. I diagnosed the existence of acute mastoiditis, due to a complete attic dam. This diagnosis called for an immediate mastoid operation on account of danger to life. The patient's father was at the front, and the grandfather desired a second opinion. To this I agreed, but insisted on its being promptly obtained on account of the danger to life. Dr. Percy Jakins was sent for and saw the patient before he saw me. When we met he at once said, "That boy has your attic dam; it is obstructing drainage, and he must undergo operation at once." The relations were satisfied, and I performed the operation within two hours. The antrum was found to be full of pus, under pressure, pent up by an attic dam (acute mastoiditis). There was no swelling behind, or displacement of, the ear. There had been no time for this to occur. Life and hearing were made safe by the operation. The other ear, however, though painless, continued to

discharge—the walls of the mastoid antrum were diseased. I therefore told the relations that I could not let this ear go on discharging indefinitely and destroy the hearing. At the end of five weeks, the conditions being similar to those indicated on Chart 2, I operated on this ear. A well-known Australian aural surgeon was present. At the end of the operation he remarked, "Before the operation nine men out of ten would have said that no operation was required on that ear, but they would not say so after seeing the conditions inside." He also stated that he was returning to Australia in a few days with seven hundred men invalided out of the army, many of them on account of chronic otitis media, and that on his arrival he meant to operate on the latter.

Mr. F. P. Sturm, M.Ch., surgeon to the Leigh Infirmary, when writing to me, also referred to the attic dam. His letter runs thus:—

"Six weeks ago I had an excellent opportunity of demonstrating the preservation of hearing by Heath's operation to several of my colleagues at the Leigh Infirmary. The patient was a 12-year-old girl, whose left ear had discharged at the age of 3; that is, for the greater part of her existence. She was quite deaf in that ear to all air-conducted sounds. A 6-feet watch could not be heard on contact. Bone conduction (tuning fork) was + 20 seconds on that side. She had been sent into the infirmary, not to save her hearing, or on account of the otorrhœa which had been allowed to persist for so many years, but because of a sudden attack of very severe pain in the ear. There was free discharge through a large central perforation (the handle of the malleus was almost completely destroyed), so the pain was obviously due to an obstruction in the attic preventing the escape of pus from a diseased antrum. The discharge was loaded with acid-fast squames. I operated that afternoon by Heath's method in the presence of Drs. Halton, Jones, Sackville, Martin, and Turner. In this chronic case, which had recently become acute, I was able to demonstrate the presence of the attic dam which Heath has described and correctly stated to be the cause of the obstruction to drainage which leads to acute mastoiditis. I was also able to show up the anatomical details of the middle-ear as closely as in a text-book diagram, and, needless to say, much more convincingly.

"A fortnight after the operation I showed the same patient to the same doctors. She could hear ordinary conversation at six feet quite well; the watch, which previously was inaudible on contact, could be heard quite plainly at four inches. There was still some slight discharge, but the large perforation was now only of the size of a pin's point, the clearly exposed antrum was in process of rapid obliteration, and all pain had ceased. Three days ago I examined her again. There was no discharge and no perforation. There was no recognisable antrum. There was practically perfect hearing. The anterior angle of the flap had sloughed a little, but was healing well. This case, which I have chosen because it was used for purposes of demonstration to an audience of medical men well able to criticise the results of the method, is but one of many. In the minds of those who have adopted this operation in their practice, or who have seen it performed by others and have watched its results, there is no doubt that it has come to stay and to be our chief means of preventing deafness from aural suppuration.

"If the operation is carried out according to Heath's instructions it is practically impossible to injure the facial nerve.

"A short time ago I was assisting one of my Hospital colleagues who was doing a Schwartze operation. When he had reached and cleared out the antrum he handed the mallet and gouge to me and said, 'Turn this into a Heath; I am not satisfied with it.'"

This remark denotes dissatisfaction with Schwartz's operation on the part of one accustomed to perform it. Yet it will cause no surprise to any experienced surgeon, because this method of opening the antrum, combined with the subsequent plugging, are procedures out of harmony with present surgical teaching. Plugging in any cavity is undesirable, but in a septic mucous one, in cancellous bone, in the neighbourhood of vital and vulnerable structures, it is a surgical abomination.

The following case is an illustration of dissatisfaction with the radical operation also :—

A medical student at one of the largest Universities in Great Britain was referred to me by an aural surgeon and teacher of otology at the chief hospital which is attached to that University. This surgeon had previously performed a radical mastoid operation upon one of the ears of the student, both of which were discharging. The results of the operation were facial paralysis, disfigurement behind the ear, and deafness (such as remains after all radical operations). He then advised the patient to come to me for operation upon the other ear by my conservative method, as it was necessary to endeavour to save the hearing on one side. The result of my operation was rapid and complete cure; the discharge ceased, the perforation healed, and the hearing returned. He subsequently graduated. After the war broke out he elected to serve his country and has since been to the front as a surgeon. This he would have been unable to do if his hearing had not been restored by operation.

The two cases just mentioned are examples of dissatisfaction on the part of practitioners with the results of the operative methods which they practise and teach, because they have been taught to do so. With the results of the radical operation no one would be satisfied. Even the patients complain of the disablement which follows this procedure. Here are two examples, both women, one poor, the other rich, which came recently under my notice. They were brought to me in the hope of some mitigation of their miserable condition. Each had undergone the radical operation on both sides. Each was completely deaf in both ears, no vibrating tuning fork being heard when in contact with the head; consequently writing was the only means of communicating with them. Each was much disfigured on both sides. Each suffered from facial paralysis on one side. One patient was not cured of the suppuration on either side, and the meatus was stenosed on both, so that nothing could be seen of the diseased conditions within. The other patient, though cured of the discharge, suffered so badly from vertigo that she could not walk without help, an attendant being required to support her. One of these patients had been treated at a London Hospital by a teacher of otology and a writer upon this subject; the other had been treated by a provincial surgeon.

These examples of the results of the prevailing teaching and of the performance of the radical operation cannot be regarded as other than disastrous, the state of the patients being worse than before the operations were undertaken.

When the prevailing system in the hands of experienced surgeons and teachers results in such disaster, is it surprising that people resort to unqualified practitioners? It is the system, however, which is at fault, and no surgical skill will make it satisfactory. Therefore the system, *i.e.*, the prevailing teaching concerning the time and method of operation, must be changed.

These cases exemplify the shortcomings of the two rough-and-ready mastoid operations which were in universal use when I commenced the study of otology. Such results will cause no surprise when it is pointed out that each of them is disfiguring, painful, and far more extensive than the disease usually warrants, and that neither of them was designed with the object of saving the hearing. Having observed the defects in the design of the old operations, I devised a new one without them. When my operation is performed according to the rules I have laid down (and given in my forthcoming work), it is practically impossible to injure the facial nerve. The disfigurement which results from the old-fashioned mastoid operations is so great that I am not infrequently asked to operate in order to get rid of it.

TREATMENT.

Patients suffering from acute otitis media should be sent to bed* and put on a light diet. A mercurial aperient and alkaline medicines appear to assist Nature's repair. The head should be well raised, for there is often more pain in the ear when the head is low. Yet this is not enough, because when the patient is in bed or up and dressed the head, including, of course, the painful ear, is unprotected. I insist, therefore, that the head and ears shall be wrapped in a thin shawl or handkerchief, or in the flannelette otitis media cap which I have designed for use in the Fever Hospitals of the Metropolitan Asylums Board (Fig 18),

FIG. 18.



and that the affected ear shall be kept very warm by frequently changed rubber hot-water bottles. In addition to covering the head and ears, it

* The circumstances of some patients do not allow of their ceasing work in order to remain in bed. For these—after incising the drum-head, or making arrangements to do so—I recommend Turkish baths and protection for the head and ears. It is advisable, nevertheless, to continue the daily observation and charted record of the tympanic conditions, in order that any new development may be promptly recognised.

has been found desirable to cover the patient's face also with a large thin silk handkerchief for some hours daily (Fig. 19). The imme-

FIG. 19.

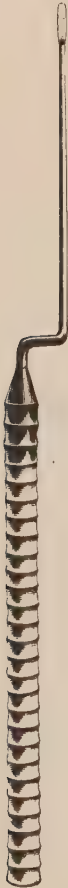


diate effect of this is to envelop it in a decidedly warm atmosphere. The warm air breathed through the nose soothes the mucosa, relieves the irritation, and tends to diminish both the secretion and the swelling, the object of this warmth and protection being to get rid of any recent "cold," or catarrhal condition, in the nose and naso-pharynx, and thus to assist in the re-establishment of the patency of the Eustachian tube (Fig. 2) and of tympanic drainage by that (the natural) route: for it is useless to expect all discharge from an ear to cease if there be no exit for secretion than through the perforation: even healthy middle-ears give off moisture which must be drained away. If the treatment already described does not relieve the pain, tympanic drainage through the meatus must be provided and the drum-head (Fig. 4) incised without delay*, even if it has already been perforated spontaneously.

* It is not desirable to let the incision of the membrane pass through an already existing perforation, else the latter may fail, or take a very long time, to heal. An incision near a perforation may be just as effective for drainage purposes without interfering with the subsequent closure of the aperture.

The nature of the predominating infection should be sought by microscopical examination of the discharge (Fig. 21), and while an auto-genous vaccine is being prepared an immediate polyvalent one can be

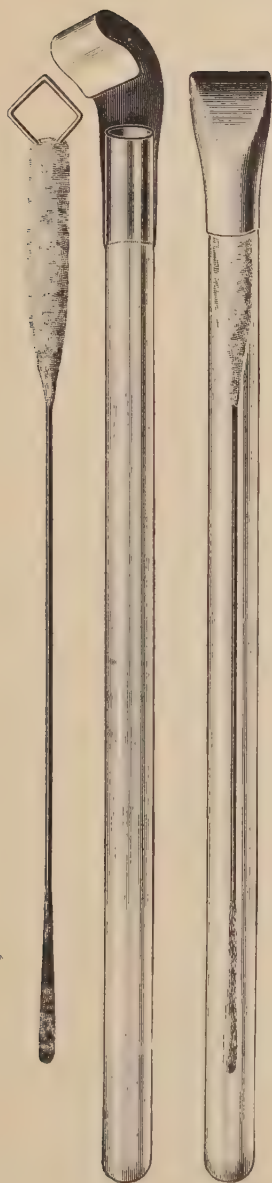
FIG. 20.



The author's paracentesis knife. The bayonet shape removes the fingers from the line of sight. The handle and shaft near the bends are blackened in order to prevent any bright reflection entering the eye and obscuring the less-illuminated drum-head; for the latter is often difficult to see when the meatus is occluded in acute disease. The handle, made as light as possible, is corrugated in order to prevent any slipping when it is held in the delicate manner all instruments should be when used in the sensitive ear. Further, the handle is silver-plated in order that it shall adhere to the fingers, and not slip as nickelled instruments do. When using this extremely light knife the resistance of the drum-head can be easily felt, however thin it may be.

administered, or a polyvalent serum given by the mouth. On very rare occasions vaccines appear to have some effect in early cases which are not polymicrobial, though, as Nature works on similar lines and rapidly cures four out of five of these cases without the help of artificial vaccines, it is difficult, in any case, to credit the latter with the

FIG. 21.



Swabs designed by the writer for taking cultivations from the ear. Sticking plaster is used to keep the swab from slipping after it has been used and replaced in the glass tube.

cure.* Further, it should be pointed out that vaccines, even when they appear to be helpful, usually work far too slowly to prevent the occurrence of tympanic changes which will cause deafness. In brief, vaccines have proved unreliable *as aids in saving the hearing*, the preservation of which should be the surgeon's goal in early cases before life is endangered.

Syringing in these early cases should not be permitted, as it is capable of adding other, and possibly worse, infections to those already causing trouble in the tympanum.† To one familiar with the anatomy of the ear, and the changes which occur when it is inflamed, it is obvious that lotions, whether driven by syringe, gravity, or otherwise, cannot be forced through the perforation and the narrow attic drainage channel‡ (the lining of which is always swollen), so as to reach the chief seat of disease, the distant cul-de-sac, the mastoid antrum; and even if they could they would do no good unless capable of bringing more blood to that cavity and more efficient drainage, and if these were provided no lotions would be required.

The old-standing custom of blowing antiseptic powders into the meatus as far as the drum-head should be condemned, first, because, these powders tend to obstruct the drainage of highly septic fluids from a dangerous locality; secondly, some kinds, when sodden with discharge, form a tough, cement-like mass, most difficult to remove—I have heard of an anæsthetic being required for the purpose; thirdly, they prevent accurate observation of the condition of the drum-head, in which the perforation may be rapidly enlarging. Further, powders, when they become sodden and putty-like, obstruct the meatus and prevent the exit of air from the tympanum, when that cavity is inflated through the Eustachian tube: their use therefore leads to erroneous opinions regarding the patency of this tube and the amount

* Dr. H. G. Adamson, in a recent article (the *Lancet*, August 10th, 1918) on "Disappointments of Vaccine Therapy," writes thus: "The uncertainty of the results, for the most part the disappointing results, of vaccine treatment should perhaps make us pause and ask, Are we at present in a position to play tunes upon the machinery of immunisation by means of vaccines after the machinery has already been set in motion as the result of microbic infection?" His experience of vaccines, in the treatment of skin disease, seems to accord with mine in the treatment of the disease herein discussed.

† Were it not for this liability, there would be no serious objection to syringing the meatus for the days or weeks during which the development of the chart is accumulating evidence for the guidance of the surgeon. Since this paper was read I have observed that another aural surgeon has, quite independently, condemned the use of the syringe in early cases of otitis media. (Edin. *Medical Journal*.)

‡ Rarely, even in chronic cases, larger than a pin-hole.

of tympanic drainage it affords. Finally, the presence of these soddened powders prevents an accurate estimation of the hearing, the daily record of which is one of the most reliable guides as to the progress of the case (see charts), and therefore as to the need of operation in order to prevent deafness.

No leeches or blisters should be applied behind the ear, as the resulting swelling and tenderness may mislead the surgeon as to the progress of pus from the antrum to the surface.

Opiates should not be administered, as it is essential that the occurrence of pain should be notified : it is usually the most important of all the symptoms.

Into the meatus a soft, conical mop of dry, sterile, and absorbent cotton wool, rolled on a suitable holder (Fig. 22), should be



FIG. 22.

A combination instrument for making the mops and inserting them ; it can be carried in a thermometer case.

inserted, and changed as often as it becomes moistened by discharge.* Over the ear a sterile gauze dressing should be placed; the cap or shawl will hold it in position.

Any nasal or naso-pharyngeal defects, especially adenoids, should be treated, by operation if obviously necessary.

Meanwhile a careful daily watch must be kept upon the tympanic mucosa, for so rapidly may destructive changes occur there that frequent observation and charted record are essential. Especially is this so when the discharge is brown or blood-stained, as this usually implies excoriation, due to the irritating character of the discharge. If, as is the rule, these raw areas are also swollen, so that opposing parts are in contact, permanent adhesions are liable to form. Frequent inflation, therefore, is desirable with the object of preventing adhesive union; and if the Eustachian tube is obstructed and precludes this procedure, it is best to perform a conservative mastoid operation, because it is a safe proceeding and it cures. Adhesions once formed, in addition to causing deafness, may cause the most distressing tinnitus.

Skiagrams and transillumination, as already stated, are unreliable guides to treatment in chronic, as well as in early acute, cases, because they do not show the swollen mucous membrane which is responsible for obstruction to drainage and for early deafness, and in late acute disease there are other signs which the veriest tyro could not fail to recognise, and in such cases skiagrams, even when reliable, are superfluous.

If it be found that, in spite of the palliative treatment already described, there is no appreciable increase in the hearing, then the disease is obviously not improving (see chart No. 2).

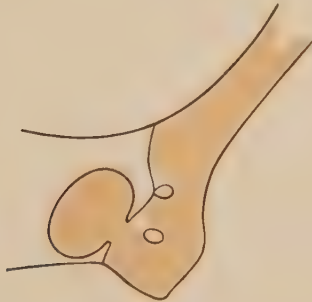
Further, if the hearing is diminishing, or the patient suffers from vertigo, the swelling of the tympanic mucous membrane (in practically all early cases the sole cause of deafness and vertigo) is obviously increasing (see chart No. 3), and this, being a natural defensive action, indicates increasing disease, for Nature provides no more tympanic defensive swelling than is required, and usually, in these early cases, no less. Increase in the swelling of the tympanic mucosa is, in itself, a serious matter, and is most pronounced in

* It is very rare indeed for the discharge from an ear to be as much as four drams (240 minims) in 24 hours, and this only occurs in acute disease. In chronic cases from 1 to 10 minims is the amount that usually escapes in a day. From these details (I have weighed the discharge) it will easily be understood how small the attic drainage channel may be, and yet adequate for the purpose of draining the anæmic antrum; for much the larger part of the discharge which escapes from a diseased ear comes from the vascular mucous membrane of the tympanum.

early cases, as in these the mucosa has had no time to become sclerosed and inelastic. If this swelling be allowed to persist, it may lead to stretching and permanent relaxation of the fragile tympanic ligaments and membranes, thus destroying the essential resilient continuity of tension of the chain of bones, and with it the perfect transmission of sounds. Then the usual result, even if the suppuration ultimately ceases, is deafness, accompanied by paracusis Willisii. Again, abundant swelling indicates a vigorous defence, which is Nature's response to aggressive disease, and is therefore a call for the arrest of disease by operation in order to preserve the hearing.

The presence of a polypus in the meatus implies the extrusion through a perforation of a portion of the irritated and œdematous tympanic mucosa ; it is thrust out. Its extrusion indicates that the

FIG. 23.



A diagram of a horizontal section through the middle-ear below Shrapnell's membrane, $\times 2$ diam. The larger open part is the deeper half of the external auditory meatus. A polypus is seen being pushed into it through a perforation in the drum-head. The middle-ear is seen to be filled with similar material to that of the polyp, *i.e.*, swollen mucosa ; this is also shown extending into the Eustachian tube. The irregular line of the drum-head, with the hammer attached to its inner side, is shown. As the swollen mucosa comes from the inner wall it has to pass on either side of the bone to reach the drum-head. This leaves a tiny space down which the discharge from the antrum is often compelled to travel in order to reach the perforation.

tympanum or attic, whence it projects, is filled with similar material (Fig. 24).

It is only among the out-of-date aurists that a polypus is treated by caustics and lotions as though it were the chief seat of disease. Up-to-date surgeons have a better knowledge of the pathology of these growths, and treat their cause, namely, the

source from which the irritating discharge comes.* For mucous polypi, whether aural or nasal, are usually the result of irritation of mucous membrane by septic discharge coming from *some other diseased area*.† (This diseased area in the case of the ear is the bony antral wall.)

If the perforation continues to enlarge, the drum-head is being destroyed, and the amount of this destruction does not always depend on the duration of the suppuration. Within four days of its commencement I have known the whole of the tense or tympanic part of the drum-head to be destroyed by the pressure of the swollen tympanic mucosa aided by the septic discharge.

* Some time ago a lady patient was sent to me by her doctor on account of an obstruction on one side of her nose, accompanied by a discharge. Examination revealed pus in the maxillary antrum, some of which was escaping through the nose and causing œdematous mucous polypi to form there (polypoid thickening of the mucosa being Nature's method of defence of the part). A diseased upper molar tooth appeared to be the cause of the antral suppuration, and the nose on that side was filled with polypi. I did not remove them, but wrote asking her doctor to see to the extraction of the decayed tooth and to send the patient to me a month later. This was done. When she came again all the polypi had disappeared, because the irritating discharge from the maxillary antrum had ceased as soon as the tooth was removed.

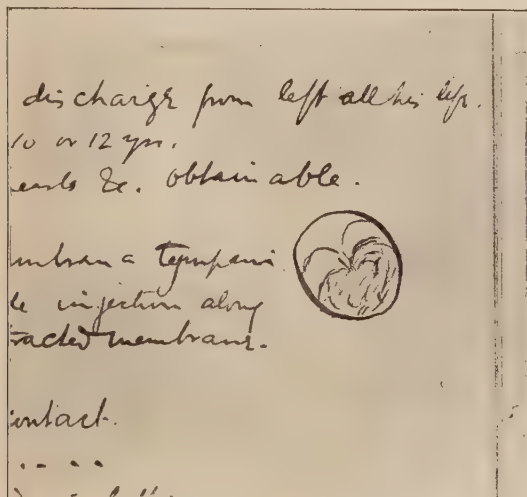
† A civil surgeon, a most experienced and progressive aurist, recently called on me and drew my attention to the futile treatment given to the discharged soldiers suffering from chronic aural suppuration (mastoid disease) who are attending a special Clinic, under the Pensions Ministry, at an ear hospital to which he is attached. He stated that these cases, even when polypi were present, were merely treated with drops and syringing, that the whole affair was "rotten," and, in any effective sense, these men were not being treated at all; the whole arrangement is unfair to the patients and unworthy of British surgery.

For a description of the so-called treatment given to soldiers suffering from mastoid disease at the Army Aural Centres I refer the reader to the *Medical Press* of December 18th, 1918. It contains an article from the pen of Mr. Adair Dighton, F.R.C.S., who had charge of one of them. He not only condemns the futility of the treatment he was compelled to give, but states that operative treatment, such as is advocated herein, would, if it had been carried out, have restored from six hundred to eleven hundred men to the Army at a time (as he says) "when every man was needed." This article shows that when competent men are appointed, their out-of-date seniors will not allow them a free hand. Competent men, however, are not always appointed—*e.g.*, a provincial aural surgeon lately released from the Army wrote to me as follows: "There is an Aural Board in this town the members of which are a general practitioner and a lip-reader." It would be better to make no aural appointments than to instal untrained men and give camouflage treatment, which leads the soldier to believe he is receiving expert treatment when he is not receiving it.

This was in a case of acute mastoiditis, drainage from the antrum being prevented by the œdematous attic mucosa—the attic dam.

The removal of the drum-head and ossicles (known as ossiculectomy, a proceeding which amounts to a sacrifice of the hearing in the hope of curing the disease) seems to have fallen into abeyance since the safety of the conservative mastoid operation (whereby the hearing is preserved) has been demonstrated.

FIG. 24.



A photograph of a drawing of a drum-head in the In-Patients' Register at the Throat Hospital, Golden Square, London. The drawing was made by the House Surgeon. The shaded lower portion shows that rather more than the lower half of the membrane had been destroyed by disease. The patient, a man, whose ear was in this condition, was totally deaf on the right side. On the left, which was discharging, and had been for twenty-eight years, the condition was as shown in the figure above. The hearing on this side gradually became worse, and finally he was discharged from his secretarial post on account of deafness. He then sought help at the Throat Hospital, and I performed a conservative operation. Within three weeks he heard so well that he was reinstated in his old position, and within a month or two Nature healed the large perforation in the drum-head. I showed this patient at a meeting of the British Oto-Laryngological Society. This is the largest perforation in the drum-head in which I have observed complete repair.

FIG. 25.



An enlarged view of the parts of the middle-ear shown in Fig. 13. A W = the anterior wall of the attic. A L M = anterior ligament of the malleus. M = the hammer (malleus). F M M = a fold of mucus' membrane. O A W = the smooth outer attic wall. S D C = small drainage channel outside the anvil ; it is always obstructed in otitis media. E B S C = entrances to bone sinuses and cells in the rough floor of the mastoid antrum, F M A. F M M = a fold of mucous membrane. T T points to the tendon of the tensor tympani muscle as it passes outward across the tympanum to be attached to the handle of the hammer. I = the incus (anvil). I A W = the smooth inner attic wall, covered with a vascular mucosa, which in otitis media swells abundantly and reaches out to and presses against the hammer and anvil, and comprises the attic dam, which, when completely obstructing the tiny inner attic drainage channel, prevents the escape of antral discharge. This condition is known as acute mastoiditis and is dangerous to life, as explained in the text. S = the stirrup ; it is low down and not easy to see. P E S C = the smooth prominence of bone covering the external semi-circular canal; the smooth floor of the aditus is to the left of it. F M A = the rough floor of the mastoid antrum. Its irregular surface, in contrast with the smooth attic walls, is noticeable, and is of greatest pathological importance.

Three cases of acute mastoiditis, endangering life, have come under my observation, in which ossiculectomy had previously been performed and the hearing sacrificed, without either curing the disease or even rendering the life of the patient safe.

In the early cases I am dealing with, examination of the fundus oculi affords no guidance as to the need of operation for the purpose of saving the hearing.

Ionisation and electrolysis are both ineffective, because the necessary fluid media cannot be forced into the diseased mastoid antrum; this is a bottle-shaped cul-de-sac, with a neck no wider than a horsehair, and is already filled; hence the folly of expecting syringing to cure. The cavity is only accessible to the surgeon by means of a mastoid operation.

Should the more important tympanic conditions already described arise and persist, or facial paralysis (often resulting from erosion of bone), or continuous pain*, the case calls for the prompt performance of a conservative mastoid operation upon the non-essential mastoid antrum and cells, in order to remove all disease from this area. In this way the septic discharge is arrested, thus enabling the tympanum and its contents, which are essential to the hearing, to recover.

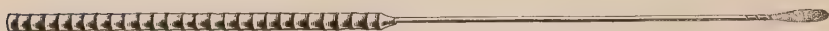
If the antral walls have not been damaged by the pent-up secretion before the drum-head has ruptured or been incised, or if, as is sometimes the case, they are smooth (and therefore protected by mucosa), the milder remedies I first described appear to assist Nature in repairing damage. If, however, the bony antral walls have become seriously involved before the drum-head is perforated or incised and the pressure thus relieved, the disease may become so firmly established that it will probably persist, and none but operative treatment will avail. This can be accomplished only by a mastoid operation. The natural tendency to repair, however, supplemented by the palliative treatment already described (of which early incision of the drum-head is by far the most effective) ensures complete recovery in more than four-fifths of these cases, without resort to mastoid operations.

When the call for operation is urgent (*c.g.*, when there is severe and persistent pain in a discharging ear, and in some also which have recently ceased to discharge) the course to be followed can scarcely be mistaken. It is a far more difficult task, however,

* Indicating retention of discharge in the antrum by a complete attic dam, *i.e.*, acute mastoiditis, with danger to life, though all the time the tympanic mucosa may be discharging freely through the perforation and the meatus.

to weigh the available evidence in early non-acute cases of aural suppuration, with the object of deciding whether Nature, unaided by operation, can or cannot cure the primary antral disease upon which the recovery of the tympanum and the preservation of the hearing entirely depend. Usually the task is not beyond her powers. We cannot see the primary disease in the bony antral walls, nor the secondary defensive changes, resulting from the discharge it gives off, which occur in the tympanic mucosa.

FIG. 26.



Wool-holder eight and one-half inches long, with cottonwool attached, for cleansing the outside of the drum-head before testing the hearing for the purpose of charting the result.

Fortunately, however, the information recently derived from the repeated performance of practically bloodless conservative mastoid operations* has so increased our knowledge of the early pathological tympanic changes and the symptoms which they cause that, with their guidance, we can now estimate the progress of a case with a nicety that was not before possible (see charts).

My mastoid operation record at the Throat Hospital, Golden Square, after introducing the conservative method, was 360 operations, with one death, and that occurred only because the operation was delayed too long. When undertaken at the proper time—that is, before the hearing is damaged—this operation appears to be no more dangerous than the removal of a tooth; if required, it ought therefore to be regularly performed early enough to prevent deafness. The hearing is well worth saving. I lost my own on one side through mastoid disease over 40 years ago. It is too late now to put it right. The remedy should be available before the hearing is destroyed. My operative method of treating this disease, which restores the hearing and does away with danger to life (see the Schedule on pp. 54 and 55), seems to be about twenty times as safe as the non-operative “wait-and-see” treatment given to the London County Council school children, for whom no hospital accommodation exists. With a suitable hospital and staff many hundreds of lives and ten times as many ears could be saved every year. A “baby week” is a good institution, but the principle might well be extended so as to include the dependent school age.

The symptoms which result from the variable amount of swelling arising in the tympanum, in defensive response to the irritation caused by the passage through it of antral discharge, are the most, and usually the only, reliable guides at our disposal. If the swelling be but slight there will be no obstruction to drainage, and consequently no pain nor marked deafness. If the swelling be considerable the deafness, at all events, will be greater, because the pressure of the swollen mucous membrane interferes with the vibration of the bones and the drum-head; and if the swelling be enough to obstruct drainage entirely, thereby setting up acute mastoiditis, the pressure upon the nerves in the mucosa by the discharge pent up in the attic and antrum usually causes pain. Pain due to any other than this condition is rare after perforation or incision of the drum-head, and its cause is usually obvious on meatal examination.

In a case of persistent aural discharge with no symptoms indicating danger to life, and in which the safety of the hearing is the immediate consideration, the question how long, and under what conditions, it is justifiable to postpone intervention by the conservative mastoid operation, becomes an interesting and serious one. The charts which I have shown, if properly used, should provide the answer. Undue delay is fraught with the risk of permanent deafness.

The natural moisture of the tympanum, upon which the physiological mobility of its contained structures, the normal acuity of hearing, and effective ciliary drainage depend, is provided by the epithelium on the surface of the mucous membrane; for there are practically no glands in the tympanic mucosa. These surface cells therefore require to be in a healthy condition if secretion, lubrication, and drainage are to be effective, else there must be some deafness. Prolonged suppuration leads to changes in the structure of these important cells; one of which is the loss of their cilia, the most important tympanic drainage agency. Another is a tendency for them to become squamous, and therefore dry. Such a metamorphosis, though a natural defensive response to irritation (and often to be observed in the nose) is accompanied by changes in the character and amount of secretion; this interferes with the normal lubrication and mobility of tympanic structures, and gives rise to deafness. If the microscope shows that acid-fast squames are plentiful in the discharge, it is rarely safe to delay operation. The presence of these dead cells in abundance in an early case usually indicate serious changes in, and desquamation from, *some part of*

the antral mucosa* (see Fig. 29). Histological examination of the discharge should be made at least once a week. Occasionally the discovery of the presence of these altered cells in the discharge is the first call for assistance by operation. But it is far more often the persistence or increase of tympanic swelling† (causing persistent or increasing deafness or giddiness, or even acute mastoiditis with pain) that is the signal for operative intervention. In either case the call is clear, demonstrable, and urgent, and must be promptly answered by a conservative mastoid operation if the hearing is to be saved; and if in these early chronic cases, long before bone erosion has endangered life, the preservation of the obviously endangered hearing is not the surgeon's chief responsibility, what in the name of common sense is?

Dr. F. A. Leslie, Ph.B., M.D., of Toledo, Ohio, wrote in the *New York Medical Journal*, August 10, 1912, under the heading "Heath's Conservative Mastoid Operation and its Pathological Foundation," as follows:—

"If the abdominal appendix is diseased, it is the general opinion that an early operation should be performed in order that the danger zone should be removed. Now, hearing is almost as important as life, yet it is the custom to tinker with the ear by the use of drops till life is threatened, before operation is suggested,

* The mucous lining of the tympanum, attic, and aditus takes far longer (usually years) to undergo such a change unless these antral cells happen to be arrested in the attic by the swollen mucosa, so that a cholesteatoma by filtration is formed there. (See the writer's contribution to the 9th Otological

FIG. 27.



An eroded hammer and
a sound one.

FIG. 28.



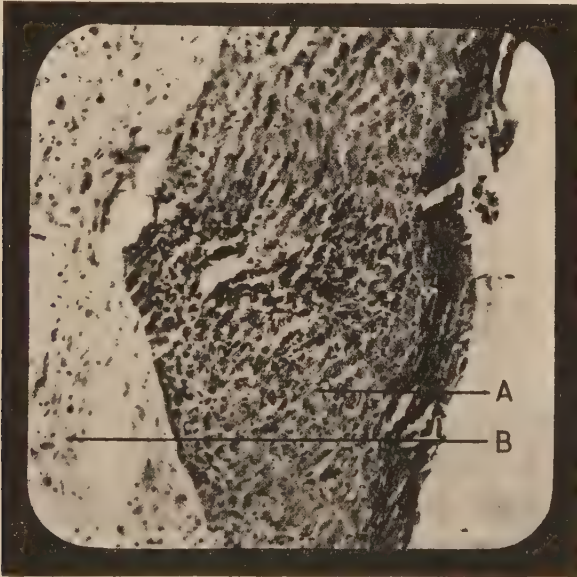
An eroded anvil and a
sound one.

Congress on early cholesteatoma). In such a case I have known the attic disorganised, the ossicles eroded (see Figs. 27 and 28), and the hearing destroyed within three months of the commencement of the disease.

‡ Because swelling of the mucosa is a much more rapid and frequent defensive response than structural change of its covering cells from a high-grade ciliated secreting to a low-grade squamous, protective and dry type.

and prior to Heath's doing it, and insisting on its being done, saving the hearing by mastoid operation does not seem to have been seriously thought of. The 'conservative' mastoid operation should regularly be performed to arrest discharge before the important structures in the tympanum have become irreparably damaged by it."

FIG. 29.



A microphotograph of a portion of the lining of the mastoid antrum which I removed during a conservative mastoid operation, performed for the purpose of arresting disease and preventing deafness. It was prepared and set up for me by Dr. Wyatt Wingrave. A points to a mass of cells on the surface of the mucosa. Usually there is only a single layer of cells here ; in consequence of irritation, due to otitis media of 14 days' duration, this single layer had taken on proliferation to the extent shown—about 20 or 30 layers are superimposed. The cells from the surface of this diseased patch of mucosa were thrown off in enormous numbers. They first appeared in the discharge about eight or nine days after the perforation occurred. As they rapidly increased in number and the hearing was deteriorating, I operated, with the result that the patient's ear was cured, perfect hearing restored, and I became possessed of valuable pathological evidence and an interesting specimen.

In a letter dated March 7, 1913, he wrote me as follows :—

“I have recently done three Heath mastoids. I operated on one two weeks ago. He left the hospital on the seventh day and has been coming to my office daily since, and I feel sure that the entire antrum and exenterated mastoid will be filled and covered with skin in one week more.”

While in London, in the month of June, 1911, Dr. Leslie assisted me in 20 of these operations, and thus had abundant opportunity of mastering the technique. As these were not hospital patients, he also assisted in the subsequent dressings, thus gaining experience of the whole procedure.

Dr. Jas. Harper, Aural Surgeon to the Royal Hospital for Sick Children Dispensary, and Lecturer on Diseases of the Ear, Western Medical School, and Aural Surgeon to Out-patients, Royal Infirmary, Glasgow, wrote to me as follows :—

“In my practice I use nothing but the Heath operation, with unqualified success. During the last nine months I have performed the Heath operation on ten cases, in three of which there were acute symptoms. The amount of shock to the patients was very slight ; indeed, in some of them was practically non-existent. The rapidity of healing and the very small amount of discomfort in the dressing of the cases was a surprise to all who saw them.

“In all these cases the hearing power was considerably improved, a matter of great importance to anyone whose livelihood depends upon his hearing.

“During the past year I have had four cases of mastoid disease with complications of the lateral sinus. In one of them the sinus was thrombosed, in the other there was a peri-sinus abscess.

“In these cases I performed the Heath operation first and then dealt with the sinus. I employed the usual Heath after-treatment, and the cases made uninterrupted recoveries. The advantages of this method of after-treatment are, that one has always complete control of the field of operation (a point one cannot be sure of if packing be used), and that there is very slight discomfort to the patient in the subsequent dressing of the wound.”

Dr. Harper's letter emphasises a point which I have often insisted upon, viz., that it is quite unnecessary to destroy the hearing by performing a radical mastoid operation merely because delay of intervention has given time for the disease to extend to

the lateral sinus or to produce a brain abscess. For if the patient survives he will surely need his hearing, and its destruction during operation does not necessarily improve the prospect of saving life.

Regarding the variable degree of toughness of the drum-head in different subjects and its variable effect in otitis media, allusion may be made to an important matter which has not yet received an adequate explanation. It is this : During the present war the ears of many soldiers have been damaged by air concussion induced by shell explosion. It appears to be the rule when the drum-head has been ruptured in this way that no injury to the labyrinth results, but when no rupture occurs the labyrinth, or some part of its capsule (the oval window), suffers. The explanation may to some extent lie in the difference in the degree of the resistance offered by fragile or tough drums. The fragile ones are ruptured by the compressed air, which then passes onward to the terminal bony cul-de-sac, the antrum, where it can do no further harm. On the other hand, the tough drums resist rupture, and are thrust violently inwards by the pressure, carrying with them the tympanic bones, the forcible driving in of the stirrup apparently being responsible for the damage to the labyrinth or the oval window portion of its capsule. The soldier you have just examined was an example of the former condition with rupture of the drum-head. Upon him I performed a mastoid operation in 1902 by the conservative method I then devised.* The perforation healed. The hearing was also restored after the operation, and is still good, though the perforation and suppuration had existed for 20 years. About a year ago, while this man was at the front, the ear which had undergone operation withstood the pressure, while the sound one was damaged, the drum-head ruptured and middle-ear suppuration set up by the air concussion resulting from the explosion of a shell. I have recently operated on this shell-damaged ear by the same conservative method I adopted with regard to the other, and, as you have been able to observe, the discharge has ceased, the perforation healed, and on this side also the hearing is now good. Prior to this operation the 50-inch watch was heard only when in contact with the ear ; now it is heard 18 inches away, the hearing being equal on the two sides. This case shows that middle-ear suppuration, even when due to heavy shell explosions, may also be curable by my method of mastoid operation, and the hearing

* An outline of this operation appeared in the *Lancet* in August, 1906. It is fully described and illustrated in my forthcoming work, together with the necessary equipment.

Source of Statistics.	Total No. of Mastoid Operations.	Total No. of Deaths.	Proportion of Deaths to Operations.	No. in which Disease in the Mastoid Antrum was observed.
DRS. FRASER and MILNE DICKIE, Royal Infirmary, Edinburgh. Published in <i>Journal of Larynxology and Otology</i> , March and April, 1912.	110 (in the years 1910 and 1911)	14	1 in 8	All
DR. JOHN BOWER, Eye and Ear Hospital, Cheltenham.	61 (about 3 years)	3	1 in 20	All
DR. PERCY JAKINS, Central London Throat and Ear Hospital.	100 (last 100 cases)	3	1 in 33	All
MR. ADAIR DIGHTON, F.R.C.S., Eye and Ear Infirmary, Liverpool, the Toxteth Infirmary, etc.	108 (in last 12 months)	2	1 in 54	All In every case obvious. One case of only 2 days' duration.
MR. CHARLES HEATH, Throat Hospital, Golden Square, London. Since the writer's introduction of the conservative mastoid operation (a period of about 4 years) the average duration of disease in these cases was 6 years. These statistics were kindly compiled from the Hospital records by Mr. George Badgerow, F.R.C.S., Surgeon to the Institution.	360	1	1 in 360*	All Nearly all obvious to the naked eye; doubtful cases verified with the microscope as naked eye observations concerning this non-vascular cavity are occasionally misleading.

The most notable feature in the Schedule is the disparity in the mortality at the various Institutions. At the Royal Infirmary, Edinburgh, the ratio of mortality to operations was 45 times as high as that at the Throat Hospital, London. This contrast is attributable to the different stages of the disease at which the patients underwent operative treatment at the two Institutions. The majority of the Throat Hospital patients referred to were under my observation and treatment for some time before operation, whereas many of those treated at Edinburgh came from remote rural districts and were not sent to Hospital until their condition was critical, when they had, moreover, to undertake a long journey, which necessitated further delay. The small mortality of 1 in 360 operations at the Throat Hospital, proves that a mastoid operation, if performed when dangerous symptoms first appear, is a remarkably safe proceeding as far as life is concerned, though usually it will be too late to save hearing. Unfortunately cases of this kind are not regularly sent to the surgeon early enough to prevent a serious loss of life and hearing. Responsibility for the successful treatment of early cases, therefore, usually rests with the family doctor. He it is who holds the reins at that early period of the disease when the opportunity to save life and hearing is greatest. But he, not being a specialist, is largely dependent in this matter on the guidance to be derived from text-books, all of which are grievously inadequate as regards the pathology and treatment of this disease during its early stage, which is, indeed, the only stage in which perfect repair is likely to be effected.

* All my (360) operations were commenced on conservative lines, yet one-third of them (119) were concluded in the radical manner. This proves that the information derived from the inspection permissible during operation by my method showed that the disease was too far advanced for the possibility of perfect repair in one-third of these cases, and indicates that the operations were performed too late to save the hearing; yet they were carried out as soon as hospital accommodation could be provided. My experience of prolonging the after-treatment in very long-standing cases of aural suppuration in which

Various Types of Operation and Number.	Deaths after various types of Operation.	Remarks.
Schwartz ... 32 Radical ... 67 Modified Radical 11	5 9 0	At the time of these radical operations or subsequently 15 of the patients underwent operations for dangerous intracranial disease, from which 9 of them died in spite of the operations.
"Heath's Conservative" ... 54 Radical ... 7	0 3	The three patients who died were in such a critical condition at the time of the radical operations that intracranial measures were at once carried out, but were too late to save life, as in the cases referred to above.
"Heath's" ... 52 Radical ... 48	0 3	Three of the 48 patients who underwent radical operations were suffering from grave intracranial disease when first brought to the Hospital, and died, like the cases referred to above. The operations were too late.
"Heath's" ... 70 Radical ... 38	1 1	The death of the two patients in this series appeared inevitable at the time of their admission to Hospital. It was, however, considered a duty to operate, as occasionally an apparently hopeless condition is recovered from.
The Writer's } "Conservative" } 241 Operation† ... } Radical ... 119	1 0	This single death was due to meningitis. As no post-mortem examination was made the route of invasion was not identified. Neither the meninges, the labyrinth, nor the lateral sinus was exposed at the operation. There was probably some latent disease in the labyrinth, as both ears had been discharging for about 30 years. The operation was undertaken too late.

the conservative operation has been performed has been most encouraging, this treatment having resulted in a further diminution of the proportion of cases which require the radical operation. In old-standing cases, therefore, the surgeon must not be impatient to bring his post-operative treatment to a close if he wishes to achieve success by saving the hearing.

The proportion of cases of old-standing suppurative, with their tardy repair after operation, should automatically diminish as soon as the profession teaches the people the need of early treatment of aural discharges in order to save the hearing. Treatment, however, must be effective; hitherto it has not been so.

The average duration of disease in my 360 cases was six years. This is far too long to wait if the hearing is to be uniformly restored; indeed, after three months of continuous suppuration so much damage will have occurred that perfect repair will be impossible in the majority of cases, no matter what operative or other treatment is adopted. It is obvious, therefore, that operation should not be delayed for three months. Further, the tympanic changes engendered by suppuration which is allowed to persist for three months, are liable to lead to more rapid deterioration of the hearing than that which naturally takes place as age advances, just as sight deteriorates. Rarely indeed is it wise to allow suppuration to continue for more than three weeks without signs of improvement.

† This operation is described and illustrated in my forthcoming work on aural suppuration, which is nearly completed. Having performed as many as 33 mastoid operations in hospital and 20 elsewhere in one month, and carried out the after-treatment myself, I have had opportunities of discovering what steps are essential. I have also made a study of the means of shortening the duration of this operation, and in consequence have been able to perform as many as seven in a morning, *i.e.*, between 9 and 1 o'clock. The average duration of the actual operations in these cases was 22 minutes.

thereby restored.* The rupture of the drum-head in this man probably saved the labyrinth from injury by preventing the forcible in-driving of the stirrup. I may here mention that several men who were rejected on account of aural suppuration, when examined as to fitness for military service, have been accepted after my conservative mastoid operations have led to the cure of the disease and the restoration of hearing.

The existence within the middle-ear of the air-chamber known as the mastoid antrum appears to render the organ more vulnerable to shell explosion than would be the case if this cavity did not exist. The explanation is probably as follows: In some people this chamber is large and contains far more air than the tympanum. It consequently comprises the larger proportion of the space inside the drum-head, within which air can be compressed. The compression of the air entails the driving inwards of the drum-head, and with it all the ossicles, the stirrup being driven unduly into the oval window of the labyrinth, thus putting sudden and violent pressure upon the fluid in which the sensitive and fragile hearing structures are immersed, possibly injuring them, and in this way also helping to cause deafness. Deafness due to the concussion of heavy guns also appears to be due to a similar cause, though in a minor degree and more frequently repeated, viz., the driving inwards (in this case without rupture) of the drum-head, with less violent compression of the air in the middle-ear, causing some damage to the labyrinth by repeated concussions of minor severity than occur in the case of shell explosions. The following is an instructive case: A few years ago a boy of 15, who as a result of scarlet fever had suffered from drum-perforation, discharge, and deafness on both sides for eight years, was brought to me by his father. I operated one afternoon by the conservative method on both of his ears. This enabled him, when old enough, to commence the study of medicine, and though only a second-year student he is now in charge of a torpedo-boat destroyer as surgeon probationer. Besides restoring the hearing the operation resulted in the obliteration of the mastoid antrum on each side, so he no longer possesses large cavities inside his drum-heads in which air can be compressed by explosions. On his ship there has been heavy gun-fire every day for the last six weeks. He states that he is the only member of the crew who is not deafened by the noise of guns, and that it does not affect his hearing in the

* I have operated in his way in many similar cases, with similar results.

least. Having short leave, he called on me three days ago, gave this interesting information, and at once rejoined his ship ; otherwise he might have been here for your examination. As there is now no mastoid antrum on either side, the air-space inside each drum-head is very small, and compression of air therein is hardly possible. So the drum-heads and ossicles move but little when exposed to the pressure of the explosions, no damage is done, and the hearing is not impaired.

For many years preceding the opening of the present war I repeatedly pointed out the impossibility of supplying the aural needs of the country with the inadequate staff and accommodation then provided. With the vast increase of ear troubles the war has brought, the inadequacy of this provision is much more obvious, and is being generally realised. Though *we cannot at present deal with a tithe of the mastoid disease* (misnamed chronic otitis media) *now affecting the army*, we nevertheless can effectively treat the ears of those who, when sent into hospital for wounds or disease, are found to be suffering from a chronic aural discharge (mastoid disease). It has been my custom to do this at a war hospital. The usual results of the conservative mastoid operation on these cases are, cessation of an old-standing aural (*i.e.*, mastoid) suppuration, healing of the perforation, and restoration of the hearing, long before the wound is healed for which the patient was sent into hospital. In such a case no extra bed is required for the treatment of the ear.

When the mastoid disease affects both ears and causes such marked deafness in both that a soldier is unfit for duty, he is perforce sent into hospital. An officer in this condition came recently under my care in London after he had been in various Provincial hospitals for eight months without undergoing operative treatment. I promptly operated by the conservative method on both his ears one afternoon, and then discovered that on each side the bony roof of the mastoid antrum had previously been destroyed by the disease, and that the dura mater had long been the only barrier between the brain and the foul pus in the mastoid antrum on both sides ! Yet in this very dangerous condition the ears, owing to ignorance as regards the cause of the disease, had been regularly syringed and drops persistently used in the orthodox way. While this futile, so-called treatment of the *results* and not the *cause* of the trouble was being carried out, the drum-heads were both destroyed by the disease. And this is the routine treatment which is still practised

and taught in the books ! I cannot too often nor too emphatically denounce it. It is bad alike for the individual and for the State, for it manufactures deaf men. Twelve days after the operation the patient was able to go out of doors without needing a bandage over his ears. He soon returned to duty, cured of the dangerous mastoid disease on both sides, but somewhat handicapped by the deafness resulting from the loss of his ear-drums. Had my operative method of treatment been carried out eight months earlier, instead of merely keeping him marking time in the hospital for that period, much more of his ear-drums and hearing might have been preserved, and he would not, for months, have occupied a bed that was possibly needed for a wounded man. Early operation would have been better for him and better for the country.*

While there is now available a safe mastoid operation, which, if performed before serious tympanic damage has occurred, will cure the disease, restore the hearing, and remove the threatened danger to life, what justification is there for persisting with the complacent and useless "wait-and-see" syringing until the hearing

* There are many similar cases to be found in our war hospitals. During the war many new methods of wound-treatment have been tried with markedly improved results. Why should not diseased and dangerous ears—so badly managed in the past—be treated in a new and more effective way?

The Metropolitan Asylums Board, having realised the gravity of the discharging ear (mastoid disease), have set up a hospital for its special treatment, when occurring among the patients under their care. This is the first institution of its kind in the world.

As severe deafness on both sides before a child is five years old often leads to dumbness, and one-half of the children in the London County Council schools who are deaf and dumb become so affected through neglected or, what amounts to the same thing, *inadequately treated* otitis media, the Council would find it more economical—to put the matter on no higher a plane—to cure the disease by operation (at a cost of between five and ten pounds) before the hearing is destroyed, than to be responsible for the troublesome duty of endeavouring to educate a deaf mute. At present the Medical Officers of the Council (about seventy in number) are unable to do mastoid operations, as there is no hospital for the purpose. These dangerous cases are consequently treated by the futile syringing method at what are known as "Minor Ailment" Centres. Surely a disease which kills two or three of the Council's school children every day should be regarded as a *major* ailment and suitable provision made for its treatment.

I see no possibility of an adequate provision for the treatment of mastoid disease in the Army. There may be one hundred thousand soldiers so affected, or five hundred thousand, or even more, for, as already stated herein, two hundred cases were observed in one regiment of a thousand men. Apparently there will be no effective ear-treatment provided for soldiers until some time

is destroyed and life is endangered? Would the patient be willing to wait if he knew the dangers? In appendicitis the "wait-and-see" treatment has had its day, and operation is performed and the danger removed as soon as the appendix is known to be diseased. The chronically discharging ear is caused by disease in the mastoid antrum—the aural appendix. We have to deal with an aural appendicitis, as I pointed out many years ago,* and the surgeon can only deal with it by means of a mastoid operation. I am glad to find that during a recent discussion of a paper read at Brisbane by Dr. Graham Brown every speaker stated that he had adopted my method of operation as a routine procedure in these cases.† The "wait-and-see" treatment of mastoid disease has had its

after peace is declared, and if provided then it will only be at the hands of civilian otologists. I am anticipating such conditions by training as many young surgeons as present themselves for the purpose and appear to be suited for the accurate and restricted operative procedures that are required. We must endeavour to be prepared to give really effective treatment to the ears of a great number of men when the Army is demobilised, for, as already pointed out, the so-called treatment given in the Army is utterly inadequate. The following quotation from an Army Surgeon's letter confirms this opinion; it is dated 22nd December, 1918, and runs thus: "I have been abroad since 1914, and my ear work has been at a standstill because I have done nothing but administrative work. Five months ago I came home, and have been acting as President of a Travelling Medical Board, where I was struck by the appalling number of ear cases, suppurative, treated on the old method. Alas! there is nothing much else that can be done in the Service; they don't pay much attention to ear cases in the Army, as you may well know, rather less than they do in any hospital in civil life." The writer of those words has obviously no respect for the "old method," which is *the futile text-book method*.

* *British Medical Journal*, July 13th, 1907. Here are the opening words of my address as President of the West Kent Medico-Chirurgical Society in 1907. This address was republished in the "Annals of Otology," U.S.A. (Sept., 1907). "Aural appendicitis is the name by which chronic aural suppuration might be known, for disease of that mucous cul-de-sac, the mastoid antrum or appendix of the ear, is responsible, according to my investigations, for the perpetuation of the discharge. Like appendicitis in the abdomen, that in the ear is also a latent danger. In both situations it is a grave disease on account of its liability to affect neighbouring and vital parts. In the abdomen it may cause local abscess or fatal septic infection of the serous peritoneum (peritonitis); in the ear it may cause local or cerebral abscess, or fatal infection of the jugular vein or the serous pia mater (meningitis). Now, no careful surgeon waits for abscess in abdominal appendicitis, nor in my opinion should he wait for it in the ear, for just as the removal of the abdominal appendix will eradicate the danger there, so will timely elimination of the aural appendix usually restore the ear to function and safety."

† *Medical Journal of Australia*, July 21st, 1917.

day in Australia. How long, in deference to misleading textbooks, is it to be tolerated here, at the cost of the loss of many lives and ears every day?

When addressing the last International Otological Congress I did not hesitate to condemn this treatment. Here are my words: "No part of otological practice appears to be in need of such radical amendment as that relating to the early management of aural suppuration. It is not of much use endeavouring to save the hearing of an ear which has already been destroyed by disease, or attempting to save a life which is beyond recall. Like appendicitis, this likewise dangerous disease needs treatment of a certain kind, at a certain stage, in order to ensure success. Salving the conscience, and prevaricating, with lotion powder and syringe, neither of which reaches the disease, are not worthy of our calling. Such petty attentions do not reach the antrum, and the schedule below proves definitely that this dangerous cavity is involved in aural suppuration. If there are to be aural surgeons, let them intervene in time to save hearing, else those assuming the title are in a false position, are sailing under false colours. I make no apology for bringing this subject forward. The statistics already given, and those in the schedule, demand a change in the interests of humanity and of surgery." (Trans. Intl. Otol. Congress.)

Though I had performed a few conservative mastoid operations, in 1902, on cases in which the conditions seemed suitable, it was not until 1906 that I became convinced of the urgent need of such a measure, and therefore put it forward for the definite dual purpose of saving the hearing and curing the disease in cases of acute and chronic otitis media (mastoid disease). Prior to this mastoid operations were regarded as such dangerous proceedings that they were never performed for the purpose of saving the hearing. Having performed nine or ten of these operations in the month of May, 1906, I published the results, and my pathological reasons for introducing the procedure, in the *Lancet* of August of that year. At the first subsequent meeting of the British Laryngological and Otological Association (on November 9th) I showed all these cases, and received unanimous congratulations on the results of the operation, which one of the speakers (Dr. Andrew Wylie, of the Central London Ear and Throat Hospital) described as "a distinct advance in aural surgery" (*vide* the *Lancet*, December 15th, 1906, for a report of the discussion at this meeting). Having thus proved that the operation was effective in its twofold purpose of curing the disease and saving the hearing, it was desirable to

bring forward evidence as to its safety if generally adopted. In this respect there was no difficulty. My Throat Hospital statistics clearly demonstrated that when performed before life was in jeopardy it was no more dangerous than the removal of a tooth. All these matters having been satisfactorily settled, it next became necessary to differentiate between the cases which required this operation in order to eradicate disease and save hearing and those which would be likely to recover spontaneously before the hearing was damaged; for my pupils required guidance in this respect. Then it was that I devised the various tests and records which are incorporated in the otitis media Charts. They are the outcome of observations on suppurating ears before, during, and after some hundreds of operations. They are, moreover, plainly demonstrable. Before these Charts were printed an American aural surgeon, to whom I explained this method of discovering what changes had taken place inside the drum-head of a discharging ear, who had not previously comprehended the means whereby my knowledge was gained of hidden pathological conditions as guides to treatment, said, "Well, it does seem simple after all." He was right. It is simple. It is necessary that it should be so, in order that it shall be generally adopted.*

This is the treatment which appears to be most effective in view of the plan upon which Nature has designed (or evolved) the majority of human ears. In a small minority the organs are so modified by development that they are less sensitive, and so less protected; they are consequently more vulnerable. We have to adapt our remedies or treatment in accordance with the needs and pathological arrangements which exist in the majority. The majority of cases of otitis media, if treated on these lines, should escape without mastoid operations or loss of hearing; the minority will need operative treatment, and the charts were devised for the purpose of inducing the aural surgeon in charge to intervene by my conservative method of mastoid operation before the hearing has been damaged, so that the individual shall subsequently be possessed of useful ears. He that hath ears to hear, let him hear.

* The three charts are merely types. No. 2 speaks for itself. It should be pointed out with regard to charts 1 and 3 that the developments which are indicated, as well as recorded in the margin, may in any case be more rapidly reached, or less. Chart 3 refers to a case in which operation was required on account of danger to life. My forthcoming work on this disease gives details of a large number of cases in which the operations were founded on diagnoses made on the lines indicated in these charts.

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No. 1

OTITIS MEDIA CHART

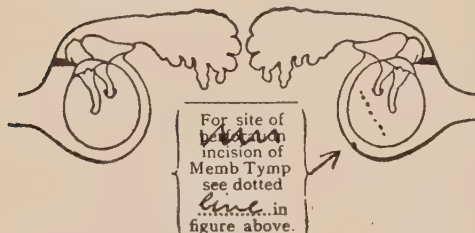
2 WEEKS

Name Thomas Brown

Age 18 yrs

Date of Admission 5/4/16

Affected Ear Right
LEFT RIGHT



Treatments 5/4/16

R Memb. Tym. incised

Anæsthetic local

Evacuated mucus (compressed)

In Meatus cotton-wool cone

Confined to Bed

Head raised on 4 pillows

Otitis media cap to be worn always

Hot-water bottle to R ear & feet

Respirator to be used at night

Diet all liquid

Medicines H&D Subchlor q-t Stat.

Sod Sal, in mist. q-t t.d

Pil cathart. h.s.s.

Note on the 9th. Rapidly recovering. The prompt relief of pressure, by incision of the drum-head, prevented any damage to the parts inside the antro-tympanic cavity.

Duration of Disease and reput

Duration of pain before

Pain since perforation incision

Condition of the ear before the

Condition of the other ear

Previous attacks none

Nose acute catarrh

Date	<u>5/4/16</u>	<u>6th</u>
Discharge—	<u>none</u>	<u>none</u>
„ Amount ...	<u>none</u>	<u>none</u>
„ Character ...	<u>mucus</u>	<u>discharge</u>
„ Bacteria ...		
„ Cells... ..		
Hearing—	<u>50 inch watch</u>	<u>in contact</u>
„ Weber ...	<u>→ R</u>	<u>ditto</u>
„ Rinne ..	<u>—</u>	<u>ditto</u>
„ Gelle ...		
„ Schwabach ...		
Eustachian Tube—	<u>obst.</u>	<u>obst.</u>
„ Valsalva ...	<u>Negative</u>	<u>Negative</u>
„ Air Bag ...	<u>do.</u>	<u>do.</u>
„ Catheter ...		
Auricle		
Meatus		
Drum-head (Memb. Tym.)	<u>white</u>	<u>white</u>
„ <u>incision</u>	<u>bulging</u>	<u>bulging</u>
„ Incision ...		
Tympanic mucosa...		
Facial Nerve ...		
Tinnitus	<u>slight</u>	<u>none</u>
Pain	<u>ceased</u>	<u>ceased</u>
Nausea	<u>after incision</u>	<u>after incision</u>
Vertigo		
Mastoid		
Eustachian Dam ...	<u>Complete</u>	<u>Complete</u>
Tympanic Dam ...	<u>?</u>	<u>?</u>
Attic Dam	<u>incomp.</u>	<u>incomp.</u>
Temperature morn		<u>98</u>
„ eve. ...	<u>99.1</u>	<u>98</u>
Pulse morn. ...		<u>70</u>
„ eve. ...	<u>79</u>	<u>70</u>

Deaf 30 hours. Cold in head 4 days.
 vision of Drum-head 3 hours - severe -
 m-head none; only a "bunged up" feeling.
 attack apparently healthy.
 50 inch watch is heard at 47 inches

pharynx slight catarrh Fauces nil

8	9	10	11	12	13	14	15	16	17	18
very little do	none									
7 ins do	15 ins									
ditto e. Pos.										
do										
do	healed									
do										
lt inc:										
b: do										
97.7										
98.6										
72										
74										

N^o 2

OTITIS MEDIA CHART

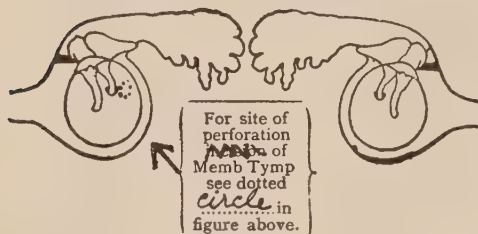
2 WEEKS

Name Wm Jones

Age 21

Date of Admission 7/5/17

Affected Ear Left
LEFT RIGHT



Treatment 7/5/17
(Left Memb. Tymp. perf'd 11 days ago)

Anæsthetic

Evacuated cleansing

In Meatus cotton cone after

Confined to warmed bedroom

Head raised on 3 pillows at night

Otitis media cap to be worn always

Hot-water bottle to feet

Respirator to be used 2 hours, t.d.

Diet light

Medicines Sodii Sal. 9x bid

Pel Cathart alt. rock.

Hearing tested daily after
cleansing the meatus.

Note 19/5/17. Slight variations
of no importance. There
is no real improvement.
The tympanic apparatus
is being damaged by the
suppuration (near 5 weeks)
conservative mastoid opⁿ
needed to arrest disease
+ thus prevent deafness.

Duration of Disease and reput

Duration of pain before per

Pain since perforation none

Condition of the ear before th

Condition of the other ear ok

Previous attacks none

Nose deviated septum

Date ...	7/5/17	8h
Discharge—		
„ Amount	purulent	
„ Character	moderate	
„ Bacteria	foul.	
„ Cells...	Staphylococcus	
Hearing—		
„ 50 inch watch	1 inch	2
„ Weber	L	dis
„ Rinne		
„ Gelle		
„ Schwabach		
Eustachian Tube—	clear	
„ Valsalva	positive	
„ Air Bag		
„ Catheter		
Auricle	nil	
Meatus	nil	
Drum-head (Memb. Tymp.)	no bulging	dis
„ Perforation...	see fig.	
„ Mucosa		
Tympanic mucosa...	Swollen + c	
Facial Nerve	nil	
Tinnitus	nil	
Pain	nil	
Nausea	nil	
Vertigo	nil	
Mastoid	nil	
Eustachian Dam	incomplete	
Tympanic Dam	Complete	Co
Attic Dam	incomplete	in
Temperature morn.		97
„ eve.	98.6	98
Pulse morn.		72
„ eve.	72	72

14 days. Measles - Second attack.

Drum-head 3 days + nights, perforation 11 days ago.
Drum-head occasional - very slight.

attack believed to have been good + was his best.

Signs of a healed perforation 50 inch watch is heard at 5 inches
Left ear

o-pharynx some catarrh Fauces congested.

10	11	12	13	14	15	16	17	18	19	20
do	do	do	do	do	do	do	do	do	do	do
no force	ditto	do	foul	do	no smell	ditto	do	foul	do	
1 in	2 in	1 in	1/2 in	1 in	1/2 in	1/2 in	2 in	1 in	1/2 in	
do	do	do	do	do	do	do	do	do	do	
obst'd		clear		obst'd						
Negative	Neg	Posv	Posv	Neg	Neg					
do	do	do	do	do	do	do	do	do	do	
heafness not enough swelling to obstruct drainage + cause pain										
Compt	Comp	inc	inc	Comp						
?	?	Comp	Comp	?						
ditto	ditto	ditto	do	do	do	do	do	do	do	
98.0	98.2	97.0	97.4	98.0	97.2	98.0	97.8	98.4	97.8	
98.1	98.0	98.2	98.4	98.2	97.8	98.8	98.2	98.4	98.2	
75	74	72	76	74	76	78	76	70	74	
78	78	70	80	82	74	78	80	78	80	

OTITIS MEDIA CHART

2 WEEKS

Name Mary Robinson

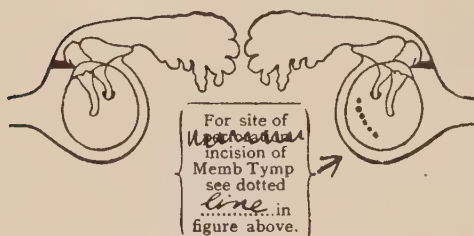
Age 6 years

Date of Admission 8/7/16

Affected Ear Right

LEFT

RIGHT



Treatment 8/7/16

R Memb. Tym. incised 5 PM.

Anæsthetic Gas (N₂O) (D-Smith)

Evacuated bloody mucus

In Meatus Cotton wool cone

Confined to Bed

Head raised on 4 pillows

Otitis media cap to be worn always

Hot-water bottle to R ear + feet

Respirator to be used 2 hours, t.d.

Diet all liquid

Medicines Troch formalin Solph

Hyd. Subchlor q. q. Statim

Sod. Salicyl q. v. in mist. t. die

Pil Cathart. R. 83,

Note on the 14th - The vertigo indicated increased swelling of the mucosa. Two days after its occurrence this swelling obstructed drainage from the antrum & caused pain & acute mastoiditis; meanwhile the tympanic secretion escapes thro' the ^{incision} perforation. Immediate opera

Duration of Disease and repu

Duration of pain before pe

Pain since perforation incisio

Condition of the ear before th

Condition of the other ear d

Previous attacks none A

Nose nil

Date ...	8/7/16	9
Discharge—	None	
Amount	before	
Character	bloody	
Bacteria	Strepi.	
Cells		
Hearing—	on	
50 inch watch	Contact C	
Weber	→ R di	
Rinne	— di	
Gelle		
Schwabach		
Eustachian Tube—	obstr	
Valsalva	Negative	
Air Bag	Neg: d	
Catheter		
Auricle		
Meatus		
Drum-head (Memb. Tym.)	Bulging	
V. Valsalva	before	
Incision	incis	
Tympanic mucosa	Swollen	
Facial Nerve		
Tinnitus	V. SLT	
Pain	deep in ear	
Nausea		
Vertigo		
Mastoid		
Eustachian Dam	Complete	
Tympanic Dam	?	
Attic Dam	?	
Temperature morn.		99
eve.	99.4	9
Pulse morn.		9
eve.	90	9

3 days, Sc Fever 2 wks ago. Temp: normal 7 days.
Incision of Drum-head 3 days, severe, no sleep = (tough drum)
Drum-head much less severe, but always some
t attack good.
Antrum past otitis media. 50 inch watch is heard at 3 inches
d removed one yr ago for mouth-breathing.
so-pharynx congested Fauces much congested.

	11	12	13	14
e ditto	increasg	ditto	profuse	
o no flood	ditto	do	pink	
to doubtful	not heard	just heard	not heard	
do	do	do	do	
do	do	do	do	
do	do	do	do	
do	do	do	do	
do	do	do	do	
Excord =	ditto	do	do	
do	do	do	do	
do	do	do	do	
visible	do	do	small polyp.	
do ditto	v. slt	slt	ditto	
	Some	ditto	severe in ear	
	Twice	once	3 times	
do	do	do	do	
?	?	?	?	
?	?	?	Complete	
0	99.1	99.0	99.5	99.8
3	99.0	98.8	100.1	100.5
-	90	91	96	98
	98	79	95	100

required

Drawn by Charles J. Heath, F.R.C.S.



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